POWER

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The Glorious Fourth

WE ARE celebrating the one hundred and fifty-first anniversary of the declaration of our determination to go it on our own; entering upon the second half of the second century of our attempt at letting the people govern themselves.

It took more than a century for the old spirit of hatred of a former foe, of chanticleering exultation of the conquerer, of the spirit of assertive superiority that goes with the tremendous success, to calm down.

It is encouraging and assuring that the village green and the public hall, which used to resound with vilifications of those with whom we have crossed arms and with adulation for those who had directed our own martial efforts, are today filled with a saner and more salutary sort of oratory; and that one participant in a hundred knows more than the first verse of the Star Spangled Banner.

There is less of fireworks and delirium, less noise and more mentality; not less appreciation of the achievements of military heroes and the sacrifices of those who have served their country in camp and on the battlefield, but a growing appreciation of the fact that the victories of peace outweigh in number and in significance the victories of war, that the development of the steam engine, machine tools, electricity, chemistry, sanitation, preventive and curative medicine mean more to the human race than all the battles ever fought and won.

That the men who have brought these things about are as worthy to be kept alive in the memory of the nation as its more spectacular heroes, and that the best thing that we can do with our quarrels and wars is to forget them.

Modern Power Plant Saves $150,000 a Year for Erie Railroad

By C. F. McKINNEY
Supervisor of Power-Plant Operation

NEW plant at Jersey City terminal replaces six obsolete ones. Steam is generated at 200 pounds and 100 degrees superheat. Turbine- and motor-driven unit pulverizers employed with one pulverizer per boiler. Summary of twelve months' operation and maintenance experience are given.

THE Erie Railroad has recently completed a steam power plant and piping distribution system to serve its Jersey City Terminal and yards, replacing, at a cost of approximately $800,000, six old, obsolete and generally inadequate plants scattered about the terminal yards, and effecting an annual saving in operating costs of approximately $115,000 plus better train operation in and out of the terminal, quicker handling of locomotives in roundhouse, and less snow and ice to remove by hand. All switches in the terminal handling main traffic operations are air operated. Therefore, it is essential to maintain at all times during freezing weather an adequate supply of steam to keep the switch operating mechanism from freezing up, as well as to melt the snow about the switch proper during snowstorms. Locomotives are fired up more quickly when an adequate supply of steam at the proper pressure is available for the blower system. These indirect savings will easily amount to $50,000 a year, making the total saving around $165,000 annually, which would be nearly 21 per cent on the investment, as well as releasing some valuable space occupied by the old plants that will be utilized more advantageously in connection with changes and improvements to be made on account of the entrance to the new vehicular tunnel adjacent.

Unit System of Firing Adopted

As is usually the case, there was a difference of opinion as to what method of firing the boilers should be employed in the new plant, but after visiting a number of powdered fuel plants already in service, it was decided to adopt the unit system of firing pulverized coal. The fact that powdered fuel fired boilers can be quickly fired up and put on the line or taken off the line with a minimum fuel loss for banked fires appeared to be favorable for the variable load conditions of the plant involved, and this feature was given due consideration, as with any other method of coal firing it would be necessary to keep at least one boiler on bank.

A maximum of eight boilers have been required to date to handle the present connected load which leaves two boilers for spares and repairs. Outside of two service men supplied by the company furnishing the pulverizers, the plant was started up and operated by inexperienced men with less trouble and interruptions than would be expected with other methods of firing under the same circumstances; only once since the first two boilers were put in 24-hour service has the plant failed to carry the load connected to it, and this was due to the piping contractor's men opening a 6-in. steam valve to the atmosphere, 2,100 ft. away, to blow out a new line. The water was lifted out of the boilers, and the pressure dropped to around 65 lb. before it was checked, but owing to the combination of electric- and steam-driven pulverizers, the results were less serious. The one motor-driven unit remained in service and restored the pressure to normal in about one hour.

Stoker-fired boilers possibly would have met this situation without a steam failure due to the bed of coal contained on the grates. However, when the water completely disappears out of the gage glass in about two minutes' time, it is desirable to stop generating steam as soon as possible, until water is again visible in the glass. With pulverized coal combustion stops as soon as the coal feed is shut off. Since a condition such as cited is rare, and since it is a matter for argument whether pulverized coal or stokers would best meet the situation, the incident cannot be regarded as serious.

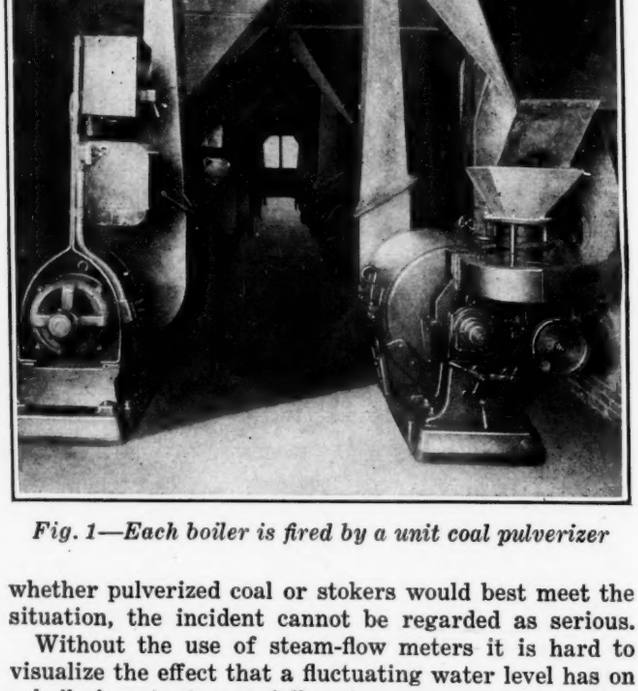


Fig. 1—Each boiler is fired by a unit coal pulverizer

Without the use of steam-flow meters it is hard to visualize the effect that a fluctuating water level has on a boiler's output, especially where a number of boilers are working together. While the water is receding in a given boiler its output will go up, and when the water begins to rise the output drops off; in other words, the load is continually swinging from one boiler to another, depending on the rate of flow of water into the boiler.

The boilers under discussion fluctuated between 100 and 250 per cent rating in about 15-minute cycles, with approximately 12-in. variation in water levels, which gives a discouraging looking chart when an attempt is being made to operate at 175 per cent constant rating.

The feed-water regulators were naturally and properly blamed for this condition. It developed that when the boiler feed pump discharge pressure was maintained only slightly higher than the boiler pressure, the feed-water regulators functioned perfectly. This led to the installation of a differential pressure regulator just back of the main regulator valve, one of which has been in service about four months, giving splendid regulation, and the other nine will be installed within a short time, after which it is believed the switching of the load from one boiler to another will practically end.

This feature was discussed simply to call attention to the condition that exists in a battery of boilers where a uniform water level is not maintained.

Prior to the operation of this plant it was believed that the load fluctuations could be satisfactorily handled by hand regulation of combustion conditions, it being contemplated to set the majority of the boilers on a constant load of 175 per cent of rating and to take care of the fluctuations in load on one or two boilers. But the load was found to fluctuate from around 17,000 to 67,000 lb. of steam in a minute's time, and the only way the fireman can tell that the load has changed is by the steam gage, which means continually over and under adjustments, and with the air for combustion seldom correct for the fuel being fed. This is effectively reflected in table No. 1, column 14, giving the average monthly efficiency. As the percentage of variation in the summer load is much higher than the winter load, three boilers being required in daytime and two at night, the firing up and cooling off of this third boiler affects the efficiency considerably.

Arrangements are under way to install automatic combustion control. After this has been done, it is believed that the guaranteed test efficiency of 78.5 at 175 per cent of boiler rating will easily be obtained as a daily operating efficiency, especially in the winter time and not lower than 73 per cent in the summer, which means that the test efficiency would show up one to three per cent higher, due to the heat loss through pop valves and blowoffs not being included in test figures.

Practically any percentage of CO_2 desired can readily be obtained by the damper and air inlet adjustment. The air-flow pen of the steam-flow-air-flow meter was adjusted to parallel the steam-flow pen at 13 per cent CO_2, as it was believed advisable to operate at a medium high furnace temperature until the operating forces were well broken in, and to observe the action on the furnace walls. The furnace walls up to the present show no indications of deterioration in any way. The furnace arches have spalled away some, but not bad enough to require any tile replacement to date. In all probability after the automatic control is in service, the CO_2 percentage will be raised to 13½ or 14 per cent and possibly higher.

The furnace walls were laid with thin fireclay joints, with ample expansion joints provided. The walls in general are glazed over, and on this surface a layer of ash collects or forms. In the less active portions of the furnace this layer is generally not over an inch thick and is readily brushed or knocked off, but in the more active portions, where the flames sweep the walls, an accumulation sometimes builds up quite thick, depending on the temperature at which the furnace is operated. The accumulation is readily gotten rid of at any time by simply raising the temperature for about an hour to approximately the melting point of the slag, and it will drop off the walls. This accumulation is presumably

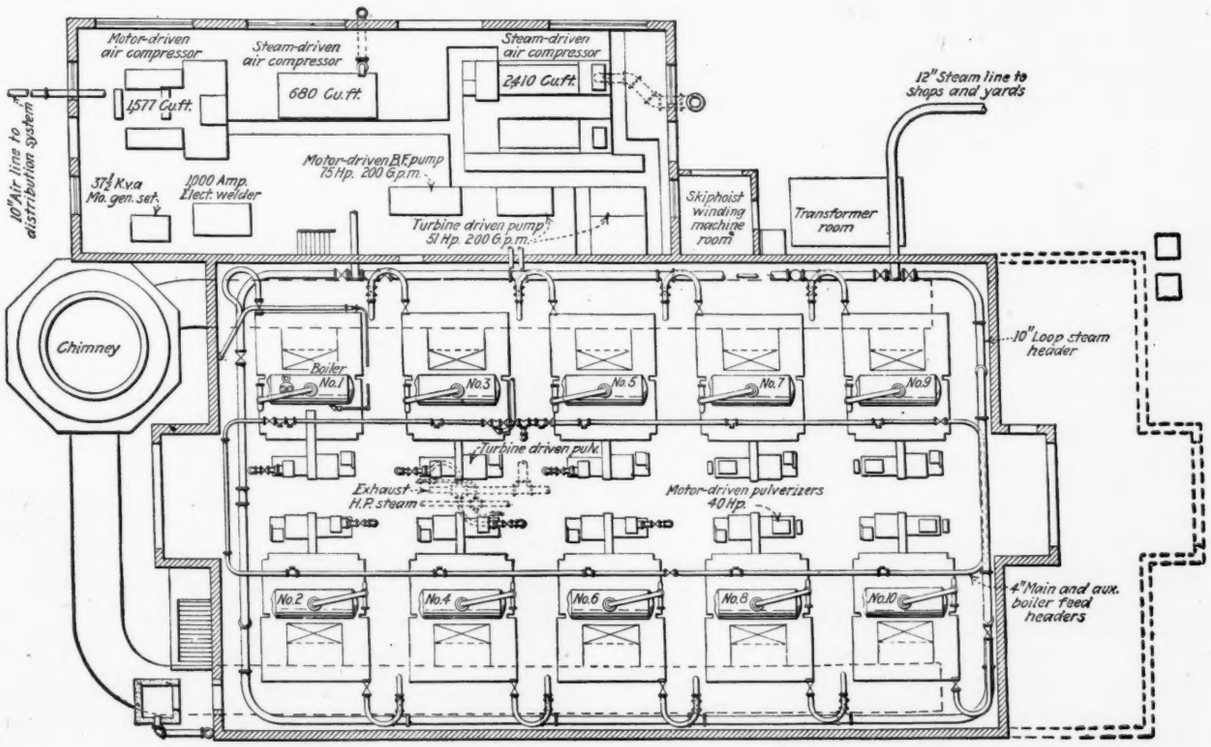


Fig. 2—Plan of plant, showing general arrangement of equipment

due to operating at intermittently high and low temperatures for short periods of time. During the high-temperature period the slag is formed, but is not melted sufficiently to run off before the furnace temperature has been reduced when another layer of ash collects, to

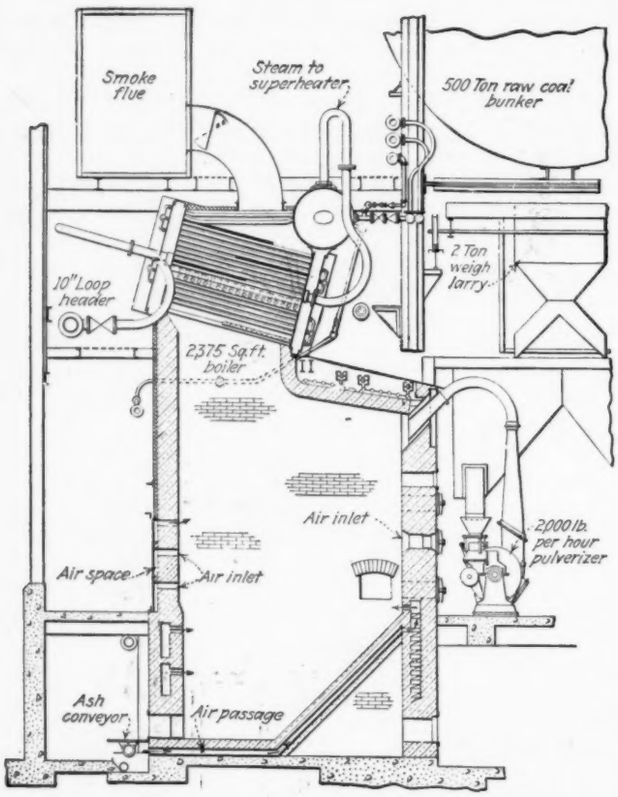


Fig. 3—Section of boiler setting and furnace

be slightly fused during the next high-temperature period. If a uniform operating temperature were maintained, either high, low or medium, there would probably be no accumulation more than a thin layer over the entire furnace, which is desirable as it is a protection from erosion of the firebrick.

The fusing point of the ash largely governs the temperature that any furnace can be economically operated at, particularly so where a water screen is not employed to keep the ash bed cool. The furnaces under discussion were not equipped with a water screen, and there has been only one case where a furnace was slagged down to give any serious trouble in removing the ash. This was soon after the plant was first started up; the boiler was kept in service, but it required about ten hours to break up and remove the slag, which is ordinarily a 20- to 30-minute job for a 24-hour accumulation.

While no definite information is available at this time as to the power required to pulverize coal, it is believed that it will not exceed the guaranteed figure of 30 hp.-hr. per ton of coal.

The boiler room steam-flow meter measures all steam used by the six steam-driven pulverizers, ash conveyor and soot blowers, and after deducting an estimated amount for the latter two uses, the steam required to pulverize one ton of coal is 1,250, or about 28 hp.-hr.

Individual electric meters are soon to be installed on the four motor-driven pulverizers, when definite data will be available.

The guaranteed figure of 6c. per ton for pulverizer repairs (material) appears so far to be conservative. This figure included repairs to pulverizers proper for wear due to pulverizing coal.

Up to the present time the paddles in the first chamber of all ten pulverizers have been renewed once at a cost of $100 for material, and the tonnage through the pulverizers at the time of change was 15,390 tons, or a cost of 6.5 mills per ton. The wear on the paddles in the succeeding three chambers appears to be proportional; that is, the wear in the second is about one-half that of the first, and the third chamber about one-fourth, with little wear in the last chamber. There being twice as many paddles in each of the last three chambers as in the first, this would bring the cost of paddle renewal up to around 1.8c. per ton. The wear on the casing liners, which are made of manganese steel, has not been great enough as yet to make any intelligent estimate of their life. A figure of 3c. per ton would appear to be ample to cover all repairs to the pulverizers, barring accidents, of course.

The yard steam distribution lines ranging in sizes from 12 in. leaving the plant down to 4 in., have a total length of 5,395 ft., all of which were installed overhead on steel supports, except about 200 feet of 6-in. line crossing a number of tracks that was put underground inside of a 16-in. cast-iron pipe, with 3-in. thick insulation intervening, and roller bearings clamped to

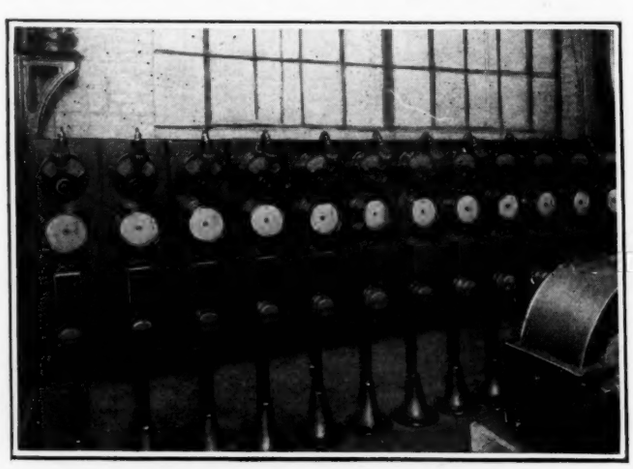


Fig. 4—Instrument board, showing indicating, recording and integrating steam-flow meters

the 6-in. steam pipe. The 16-in. cast-iron pipe terminates in concrete pits, making the line watertight.

Building designed by Graham King, architect. Plant equipment and piping distribution lines by the writer.

The erection was handled by C. H. Splitstone, superintendent of construction, with W. I. Jefferds, resident engineer in direct charge of the erection, and J. Carney, who now is operating engineer of the plant, as mechanical inspector.

Details of Mechanical Equipment Installed

Ten 2,375-sq.ft., 200-lb. pressure U. S. Shipping Board water-tube boilers known as the "Standard Boiler," built by Erie City Iron Works, modified and equipped with Foster superheaters by the Power Specialty Co. The superheaters were designed to add 100 deg. superheat to the steam.

Ten 2,000-lb. per hour "Aero" unit pulverizers, furnished by the Economy Equipment Corp. Six are direct-connected to 40-hp. Westinghouse steam turbines through reduction gear, and four direct-connected to 40-hp. 1,200-r.p.m. electric motors.

One 40-ton per hour automatic skip-hoist coal-handling

equipment, consisting of a 500-ton overhead steel coal-storage bin, lined with Hermastic enamel, with a two-ton weigh larry for distributing the coal to the pulverizers; coal crusher and magnetic separator at the top of the bunker, and a track hopper for unloading coal cars and filling the skip hoist bucket automatically, furnished and installed by the R. H. Beaumont Co.

One Detrick-Hagan steam-jet ash-conveyor-system, consisting of three 6-in. conveyor lines, discharging into a 60-ton tile overhead track storage bin. Two of the conveyor lines are in the basement, one each back to the two rows of five boilers, with two suction openings per boiler. The third conveyor is divided into three 4-in. branches, serving the two smoke flues, and base of the stack. Up to the present time this conveyor has not been required, as the smoke flues and stack are self-cleaning. Approximately 50 per cent of the ash drops to the bottom of the furnaces to be handled by the conveyor system, which in general is a fine sand-like powder.

One 12-ft. inside diameter by 200-ft. high radial brick chimney built by the Alphons Custodis Chimney Construction Co.

Two 100,000-lb. per hour Cochrane open-type feed-water heaters.

One 250,000-lb. per hour Cochrane V-notch feed-water meter.

Three 200-gal. per min. Worthington four-stage centrifugal boiler-feed pumps, two of which are driven by Westinghouse, 51-hp. steam turbines, and one by a 75-hp. motor. One pump is required in the summer and two in the winter time with the third as a spare and for boiler washing purposes.

One 2,410-cu.ft. per min. Ingersoll-Rand cross-compound steam-driven air compressor.

One 680-cu.ft. per min. Chicago Pneumatic Tool Co. cross-compound steam-driven air compressor transferred from one of the old plants.

One 1,577-cu.ft. per min. Ingersoll-Rand type cross-compound motor-driven air compressor, direct connected to a 264-hp., 2,300-volt, Westinghouse synchronous motor. Transferred from one of the old plants. The two latter compressors are used as standbys and spares.

One 525-sq.ft. Worthington air after-cooler, which cools the compressed air to between 70 and 80 deg. F. before it enters the storage reservoirs.

One electric substation for distribution of public-service power about the terminal.

Ten Type D-26 Bailey boiler flow meters, one on each boiler connection to main steam header.

Twelve Type F.E.-4 General Electric flow meters installed on the various steam and air distribution lines about the terminal, with the recording panels located in the engine room.

Three Bristol temperature and pressure recording gages for recording the superheated steam and feed-water temperature, and steam and air pressure.

One Bristol two-pen portable recording thermometer, to record the steam temperature at various points in the distribution lines so that the drop in superheat can be determined, as well as the effect on the superheat passing through reducing valves.

Ten S.C. feed-water regulators installed one on each boiler feed connection.

Ten Golden-Anderson triple-duty non-return valves installed between superheater and main steam header connection on each boiler.

Two Republic CO_2 recorders, each connected up with a manifold pipe arrangement to serve five boilers, which permits checking combustion conditions on any of the boilers.

Ten furnaces erected by the Bishop Contracting Co., all furnace walls lined with Walsh XX firebrick from 12½ to 18 in. thick.

Pipe insulation furnished and installed by Johns-Manville Co. All inside and outside distribution piping was furnished and installed by C. M. Brown & Co.

All steam piping, both inside the plant and the distribution lines were insulated with sponge-felt insulation applied to thicknesses as shown in the following table. All outside insulation was protected with an asbestos felt roofing jacket, wired on with No. 14 copper wire on 6-in. centers, with all laps and joints cemented up.

TABLE NO. I—SUMMARY OF OPERATION RESULTS FROM FEB. 1, 1926 TO JAN. 31, 1927, INCLUSIVE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
							Boiler Plant Operation								
Month, 1926.	Tons of Coal Used	Million lb. of steam generated (power house consumption deducted).	Approx. cost per 1,000 lb. steam distributed (including overhead and freight on fuel).	Operating cost and foreign freight on fuel only.	Million cu. ft. of air compressed for distribution.	Cost of air per 1,000 cu.ft. (operating steam cost only).	Average steam pressure (gage).	Average feed-water temperature.	Average steam temperature.	Actual evaporation pounds water per pound coal.	Total B.t.u. in 1 lb. steam above 32 deg.	B.t.u. added to 1 lb. of water and steam = column 11 + 32 less feed-water temperature, Column 9.	Total B.t.u. utilized per lb. of coal. Column 13 × Column 11.	Over-all daily operating efficiency per cent.	Per cent of steam generated used in operating plant. Corrected to include all coal to be pulverized by steam.
Feb.	2,799	44.5	68.2	30.0	45	3	....	....	496.3	8.99	1,266	1,118	10,050	75.4	10.4*
Mar.	2,533	41.0	68.2	30.0	54	3	185	180	496.5	8.843	1,266	1,103	9,760	73.2	12.4
Apr.	2,076	24.3	76.6	32	51	3.2	186	195	494	8.7	1,264.5	1,085.25	9,445	70.85	14.3
May	1,398	18.0	124	51	44	5.1	187	211	501.6	8.48	1,268.6	1,086.6	9,210	69.1	15.8
June	936	13.5	153	62	38	6.4	188.5	214	519.7	8.05	1,278.4	1,091.4	8,790	65.9	15.0
July	937	11.5	175	71	38	7.38	186	219	507	7.8	1,272	1,085.5	8,470	63.5	14.8
Aug.	871	11.5	175	71	33	7.38	185.1	218.5	471.5	8.08	1,253.7	1,071.7	8,659	64.9	13.3
Sept.	962	13.0	153	62	35	6.4	173.5	214	473	8.37	1,254.7	1,077.7	9,020	67.7	10.5
Oct.	1,898	22.5	112	44	40	4.6	172	209	481.7	8.52	1,259.13	1,094.13	9,322	70	8.9
Nov.	2,063	31.0	73	32.62	42	3.392	175.3	197	483	8.65	1,260	1,085	9,385	70.45	8.55
Dec.	3,363	57.5	66	26.37	47	2.74	174	207	469	8.58	1,252	1,070	9,258	69.5	7.7
Jan., 1927	3,261	53.5	67	27	47	2.8	174	205							
Total	22,271	346.5	....	....	514	....	....	....	....	....	....	....	....	....	....
Aver.	1,856	28.87	87	35	42.8	3.64	180.4	206.5	490.3	8.55	1,263.5	1,089	9,311	70	11.2

In noting column 16, it should be borne in mind that the average stoker-fired plant requires from 4 to 6 per cent of the boiler output to operate the stokers and forced draft equipment.

TABLE II—OPERATING FORCE EMPLOYED IN CONNECTION WITH PLANT

Position Filled	No. of men employed 1st Shift 8 A.M. to 4 P.M.	2nd Shift 4 P.M. to 12 P.M.	3rd Shift 12 P.M. to 8 A.M.
One chief and one assistant chief engineer covering 24-hour period	1	1	1
Shift engineers	1	1	1
Firemen, winter months (during summer one fireman per shift with a fourth man for relief duty)	2	2	2
Coal larry operator	1	1	1
Ash handler	1	..	..
Coal handler	1	..	..
Laborers	2	..	..
Total during winter months (18 in 24 hours)	9	5	5
Total during summer months (15 in 24 hours)	8	4	4

TABLE III—PIPE INSULATION THICKNESSES ON ALL HIGH-PRESSURE LIVE-STEAM LINES

Pipe Size	Thickness Inside Piping	Thickness Outside Piping
1½ in. and smaller	1½ in. one layer	2 in. two layers
2 to 4 in. inclusive	2 in. two layers	2½ in. two layers
4½ in and up	2½ in. two layers	3 in. two layers

Power Factor Simplified

Explains What Wattless or Magnetizing Current Is and Its Effects in Loading Generators and Prime Movers

By P. W. SAWYER

AN ALTERNATING current is continually changing its direction in the circuit, consequently the circuit is magnetized and demagnetized at the frequency of the current. Energy is stored in the magnetic field of an electric circuit, just as energy is stored in a moving mass, such as a flywheel. When the flywheel has been put in motion, if the source of driving power is cut off, it will continue to revolve for a period and do work, such as overcoming the friction of its own bearings and driving connected machinery. In the same way, after an electric circuit, such as a coil on an iron core, has been magnetized, if disconnected from the source of power it will give up energy that can be used to do work.

For example, if a lamp is connected across the field coils of a direct-current motor and the coils excited,

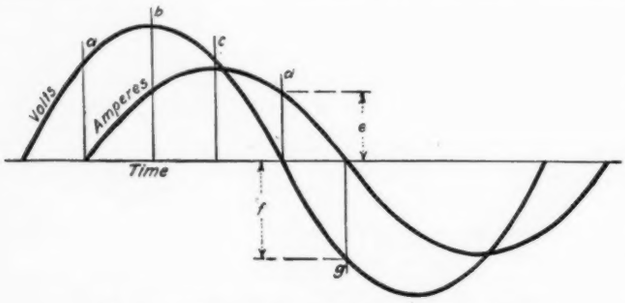


Fig. 1—Current curve lags the voltage

when the switch is opened it will be found that the lamp will burn for a short time after opening the switch. This is due to the magnetic field of the circuit decreasing and generating a voltage that tends to maintain a current. In this way the energy stored in the magnetic field is expended in the circuit, just as energy stored in the flywheel was given up to the mechanical system as the wheel slowed down.

Magnetizing Current in the Circuit

Since an alternating-current circuit is being continuously magnetized and demagnetized, as shown in the previous article[1], a magnetizing current flows in the circuit in addition to the power current. The combination of the magnetizing and the power currents gives a resulting current that lags behind the voltage, as indicated in Fig. 1. On these curves the current begins to increase in value in the same direction as the voltage at instant *a* and flows in this direction until instant *d*. At this point the generator voltage is zero, but the current is at a value represented by the distance *e*. During the period *a* to *c*, Fig. 1, while the current was increasing in value, part of the energy supplied by the current to the load was expended in useful work and part of it was stored in the magnetic field. As the current decreases in the circuit, the magnetic field decreases and induces a voltage that tends to maintain the current at a higher value than represented by the generator voltage.

As a result, at instant *d* on the curves when the generator voltage has decreased to zero, the current has a value represented by distance *e*. At this point the voltage of the generator reverses, but the current does not decrease to zero until instant *g*. During the period *d* to *g*, the load is the generator and the generator the load; in other words, the load supplies energy to the generator to drive it as a motor. The energy supplied to the generator represents that which was stored in the magnetic field of the load during the period that the current was increasing in value.

Energy Stored in the Magnetic Field

From the foregoing it is seen that on the first half of the current wave a certain amount of energy is stored in the magnetic field which is given back to the generator during the last half of the alternation. Theoretically, this energy does not require any work to be done by the prime mover, since the energy given back to the generator on the last half of the current wave is equal to that supplied to the magnetic field on the first half of the current wave. Practically, this is not correct, since there are losses in the system that must be taken into account. These, however, represent only a small part of the total energy of the magnetic field.

As the current that magnetizes the circuit at one instant and transmits this energy back to the generator at the next does not actually supply any power to the load, it is sometimes called a wattless current. This is not practically true, since power is transmitted in one direction in the circuit during the first part of the current wave and in the opposite direction on the last part.

Hydraulic Analogy of Wattless Current

A hydraulic analogy of this wattless or magnetizing current is shown in Figs. 2 to 5. In these *P* is a piston, with a valve *A*, in a long cylinder and is at the beginning of its stroke in Fig. 2. At the discharge end of this cylinder is an air chamber *C*. When the piston starts forward, the discharge valve *A* will not open until the air in chamber *C* has been compressed to a point where the pressure in the cylinder is slightly higher than it is in the discharge pipe *S*.

Assume that this operation requires the first quarter of the stroke, as in Fig. 3, then during the other three-quarters water will be delivered to the discharge line through valve *A'*. At the end of the stroke the condition will be as represented in Fig. 4. During the stroke the work done on the piston by the prime mover has been utilized in two ways—one, compressing the air

[1] May 24 issue, page 773.

in chamber *C*, and two, delivering water to the discharge line.

The compressed air in chamber *C* is similar to the magnetic field in the electric circuit in that energy is stored in it. In the electric circuit the stored energy is delivered back to the generator to run it as a motor, and in the pump it is supplied to the piston to assist in returning it to the beginning of the forward stroke. As the piston starts on the return stroke, the admission valves *A* will not open until the pressure in the cylinder decreases slightly below that on the piston's intake side, as indicated in Fig. 5. During this period the energy stored in the compressed air is utilized in driving the piston and relieving the prime mover of doing an equal amount of work. Consequently, for part of the stroke the piston may be considered as doing no useful work, since the work done in compressing the air on the forward stroke is stored in the form of potential energy that is expended in work on the piston during the return stroke.

The water that flows in and out of the air chamber is similar to the magnetizing or wattless current in the electric circuit. The amount of water delivered to the air chamber reduces the useful capacity of the pump by that amount. In the same way the magnetizing current in the electric circuit reduces the useful capacity of the generator.

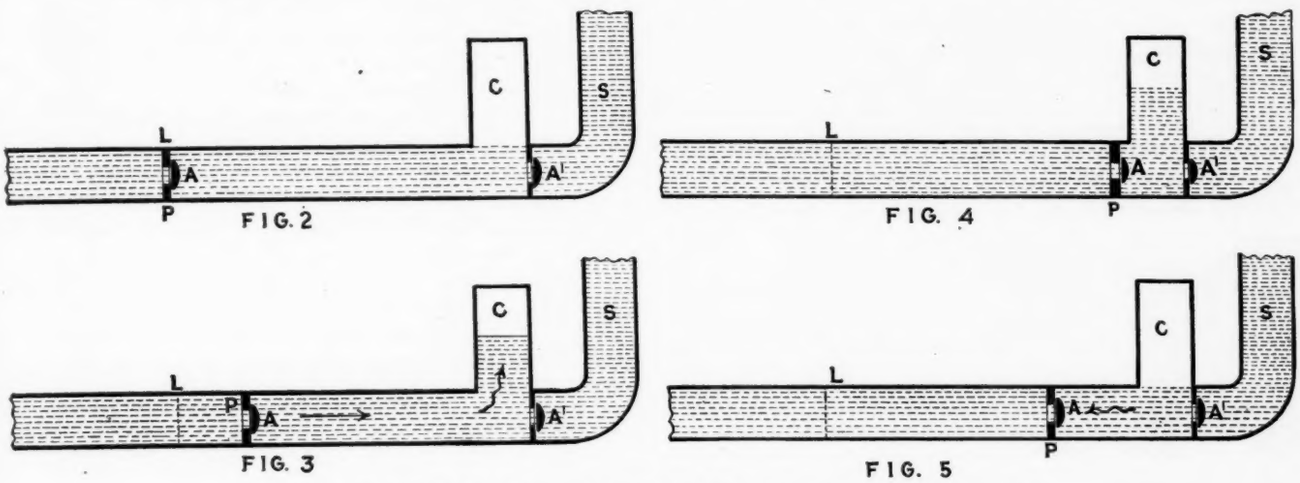
If an ammeter is connected into the circuit, as in Fig. 6, it will give a combined reading of the power and the magnetizing currents, as the meter will indicate either direction of current flows. Therefore, if this reading were multiplied by the volts, it would give a value that is too high for the useful watts supplied to the load. In the same way for the pump, Figs. 2 to 5, if the volume of the cylinder were multiplied by the number of forward strokes, it would give a value too high for the volume of water supplied to the discharge line.

Power Factor of the Load

With the electric circuit part of the current is used at one instant to transmit energy to the load that is not utilized but is stored in the magnetic field, only to be given back to the generator at a later instant. On the forward stroke of the pump part of the water displaced by the piston is pushed up into the air chamber, only to flow back into the cylinder on the return stroke of the piston. The water that is stored in the air chamber reduces the effective capacity of the pump by that much. If the pump makes one-quarter stroke before the discharge valve opens, 25 per cent of its useful capacity is lost, and the pump is only 75 per cent as effective in doing useful work as it would be if the air chamber did not exist. Similarly, in the electric circuit, if 25 per cent of the current is required for magnetizing, the generator's useful capacity to supply power is reduced by this much. This is only another way of saying that the power factor of the load is 75 per cent, or 0.75. In order to obtain the watts supplied by the generator under these conditions, the product of the volts and amperes will have to be multiplied by 0.75.

Reading of the Wattmeter

A wattmeter connected in an alternating-current circuit will indicate the watts and not the volt-amperes, or product of volts and amperes. This will be made apparent by a consideration of Figs. 7 and 8. Beginning at instant *a* on the current curve, Fig. 1, the current begins to increase in value in the same direction as the voltage and continues to do this until instant *c*. Assume that the foregoing has taken place in the generator. During this period part of the energy transmitted by the current has been expended in the load and part of it was stored in the magnetic field. The part stored in the magnet field manifests itself in a voltage that maintains a current in the circuit after the generator voltage is reversed.



Figs. 2 to 5—Hydraulic analogy of the effects of a wattless current

While the generator voltage and current are in the same direction, they have the correct relation in the current and voltage coils of the wattmeter as indicated by the arrows in Fig. 7. During the period from *a* to *d*, Fig. 1, the wattmeter not only registers the power supplied to the load, but also that used in magnetizing the circuit and is stored in the magnetic field. From *d* to *g* the current flows from the load to the generator against the voltage of the machine, being maintained by the energy stored in the magnetic field. During this period the load is supplying energy to the generator to run it as a motor. This is shown in Fig. 8. The current flows from the positive terminal of the load through the generator and back to the negative terminal of the load. Current also flows in this direction through the voltage coil of the wattmeter. This is a reverse direction from that shown in Fig. 7.

Changing the direction of the current in the voltage coil of the meter without reversing it in the current coil, will tend to reverse the direction of the meter. This

reverse action takes place for such a short period that it only retards the meter. This retarding effect is sufficient to cause the meter to indicate the energy expended in the load only. The energy stored in the magnetic field tends to speed the meter up during the period that the generator is supplying power to the load. However, the slowing-down action when the load is supplying power to the generator, retards the meter, and it indicates or records only that expended in the load.

From the foregoing it can be seen that the current may be divided into two parts, one that is used to transmit energy that is expended in the load and another part that is used in magnetizing the circuit. The latter first transmits energy from the generator, which is stored in the magnetic field of the circuit. When the generator voltage decreases, this energy is delivered back to the generator to drive the machine as a motor. This energy then at one instant tends to load up the prime mover driving the generator, but at an instant later is given back to the generator to drive it as a motor and relieve the prime moving of just that much load. If these two actions are equal, it is evident that no power is required on the part of the prime mover to supply the magnetizing current. This is true, except for some losses in the system, as previously mentioned.

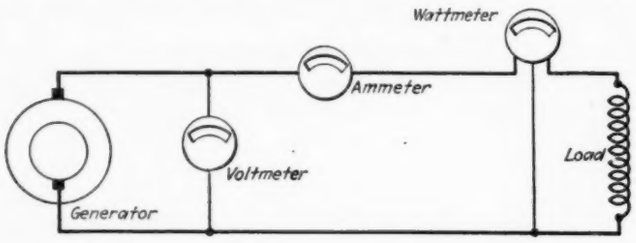
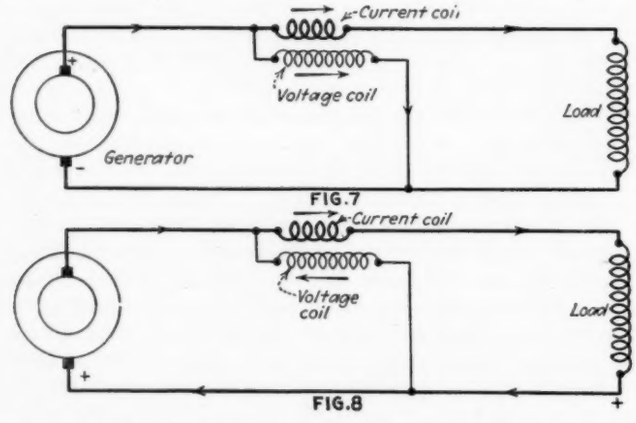


Fig. 6—Diagram of alternator connected to a load

Rating of Generators

Although the magnetizing current does not load up the prime mover, it does load the generator by increasing the temperature of the windings, just as the load current does. For this reason generators are rated on a power-factor basis; for example, 4,000 kw. at 80 per cent power factor, or 5,000 kva. at 80 per cent power factor. This does not necessarily mean that the generator will operate at 80 per cent power factor, as the power factor of the load is determined by the kind of devices supplied by the machine. Incandescent lamps have a power factor of about 100 per cent, and induction motors at full load will have a power factor of from about 70 to 90 per cent, depending upon the size and speed of the machine. At part loads the power factor of these machines will be less than these values. The power-factor rating given the generator is an attempt to obtain a machine that will be best suited to the average conditions in the system on which it will operate.



Figs. 7 and 8—Diagrams showing direction of current flow through wattmeter coils

The prime-mover capacity is generally based on the kilowatt rating of the generator. If the generator is rated at 4,000 kw. at 80 per cent power factor, the turbine will be given a rating of 4,000 kw. At these ratings, when the generator is supplying a load of 4,000 kw. at 80 per cent power factor, both it and the turbine will be loaded to rated capacity. If the load on the generator has a 100 per cent power factor, the turbine will be 25 per cent overloaded if it drives the generator at 5,000-kva. load. If the power factor is less than 0.80, the heating of the generator will determine how much power load can be supplied.

What Do You Know?

TECHNICAL folks are often accused of lacking a broad cultural point of view. Devoting time to the solution of engineering problems, it is assumed the typical engineer does not lift his eyes beyond the horizon of his practical work. But is this true? Do not more of us know Babe Ruth's batting average than we do the average Rankine efficiency of a steam engine? The ten questions below may help some to gain additional engineering data and correct answers may be assurance to others that they have not allowed cultural interests such as sport records to interfere with the absorption of fundamental and important technical data. Answers by the editor appear on page 12. Do not hesitate to challenge an answer if it does not meet with your approval.

Ques. 1—What is the largest steam turbine ordered in the United States?

Ques. 2—In a Corliss engine is equalization of the cutoffs of the two steam valves possible at all loads?

Ques. 3—How many expansions in volume take place in a cylinder with an initial pressure of 200 lb. and the exhaust going to a condenser at 28-in. vacuum?

Ques. 4—Name seven other fluids that have been used or proposed in place of or in conjunction with steam for power generation.

Ques. 5—Does a horizontal-tubular boiler weigh more than the water it contains?

Ques. 6—In what power plant was the commercial feasibility of pulverized coal first demonstrated?

Ques. 7—Does the kind of refrigerant used, such as ammonia, carbon dioxide, sulphur dioxide, etc., influence the horsepower needed to produce a ton of refrigeration?

Ques. 8—In the usual four-stroke-cycle Diesel engine does a fuel pump plunger for a particular cylinder make a stroke for each revolution or a stroke per each two revolutions?

Ques. 9—Who built the first alternating-current induction motor?

Ques. 10—What is the effect of throttling the discharge of a centrifugal pump?

With Some Brains and a Few Tools

An Engineer Installs a New Machine

By JAMES F. HOBART

JARED STOCK had learned all the engineering he knew in the Cameron Mill. So, when the mill found it necessary to buy another engine and announced that it was up to Jerry to install it and make all the connections, it is not surprising that he felt a little nervous.

A survey of the available tools revealed that a ½-ton rope tackle, two 2-ton jackscrews, two crowbars, a sledge hammer, an 18-in. and a 12-in. monkey wrench and a machinist hammer were about all he could collect. Nevertheless, he laid out the foundation and superintended the pouring of the concrete, after setting up the templet, which was made from the builders' blueprint.

Jerry Awaits the Engine's Arrival with Some Trepidation

When all was finished, he figuratively leaned back and awaited the arrival of the engine. As the days crept by without any news, he had ample time to review what he knew about engine erection and was forced to confess that it was mighty little. In fact, he was beginning to display the nervous temperament of an opera singer by the time the flat car holding the heavy girder-frame engine was kicked upon a team-track siding where there was neither platform nor unloading crane.

The railroad siding was about 500 ft. from the engine foundation, and a log truck was borrowed to haul the engine. Two 12x12-in. timbers were placed on top of

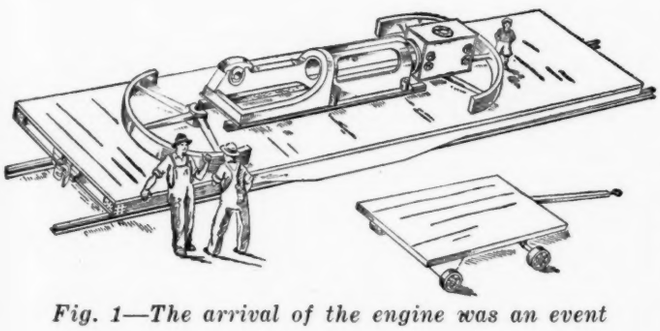


Fig. 1—The arrival of the engine was an event

the log truck, which was then backed up close to the side of the flat car.

A near-by pile of railroad ties were borrowed and a "cobhouse" of ties was built up under and beside the logging truck. The engine frame was cut around it and then worked out over the truck. The bed was then jacked down and hauled to its destination. Here it was lowered into place upon the foundation and the first snag was struck.

There were two lengths among the ten anchor bolts, and each of the ten was found to be two inches too short—a blueprint mistake evidently. A call to the local garage brought out a welder who cut the bolts and welded extensions of the correct length.

To level the engine bed a dozen 3-in. pieces were cut from a wagon wheel rim and forged into flat thin wedges. These wedges were left in place permanently,

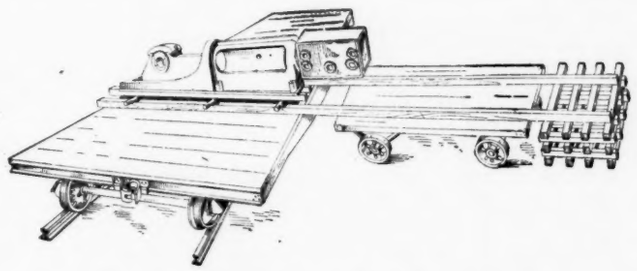


Fig. 2—How Jerry unloaded the frame

and neat cement mortar was tamped under the bed until the space between the engine and foundation was filled solid.

The outboard shaft bearing was squared with the cylinder center line by placing the crank alternately on either dead center and bringing the end of the connecting rod fair with its place in the crosshead. The outboard bearing was shifted slightly to bring the shaft square. The connecting rod was, of course, disconnected from the crosshead while the adjustment of the crankshaft bearing was being made.

How a Crowbar Becomes a Spanner Wrench

No wrench, except the 18-in. monkey, was available for tightening the foundation bolts. Accordingly, Jerry seized upon the poorest of the two crowbars and, after heating it, beat the pointed end so that the bar would fit like a spanner about the big nuts. That spanner wrench surely did its work quickly and well. Before the shaft was aligned, the two pulley or flywheel halves which came with the engine were juggled off the car and hauled over on the truck. Before putting the engine shaft into place, the workman put half of the flywheel into its place in a very neat manner. The truck carrying the wheel was hauled to within a few feet of the pit, above which Jerry hung the chain tackle. The rope tackle was hung just above the end of the truck, and a hitch was made to the split hub of the wheel with both sets of tackle, the chain being set to pull the wheel toward the wheel pit. By holding back with the rope tackle, the wheel half was lifted from the truck by the chain tackle and lowered to the bottom

of the pit, where it was left lying at an angle of about 45 deg. Then the shaft was unloaded in a similar manner, put in its place and squared up as previously described.

After the shaft had been set, another hitch was made upon the hub of the flywheel half, and it was raised to

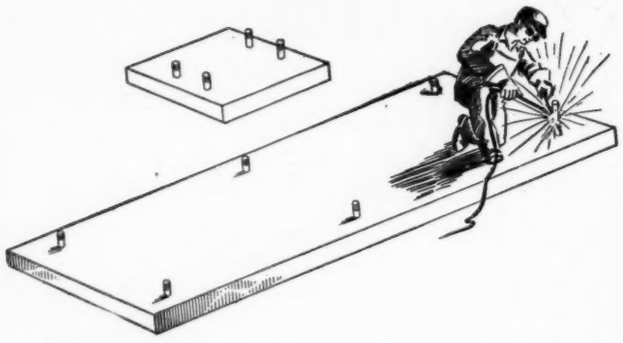


Fig. 3—The welder used his "bolt stretcher"

its permanent position, so the keyways came fair with each other. Then it was securely blocked underneath and wedged against the shaft. A hitch was then made with both sets of tackle to the second half of the wheel, which was hauled clear of the truck and swung into place.

After the wheel halves had been securely bolted and matched together, Jerry made sure that all the blocking and wedges were removed from underneath the wheel. A helper was given a 2-lb. forging hammer, and during all the time the hub bolts were being tightened with the home-made spanner wrench, he was required to strike light blows against the head of the bolt. In this manner all the slack would be taken up.

Piping the Job

The steam and water piping for the new engine and boiler was put up by Jerry and his helper, without outside assistance. Not having pipe-threading tools of his

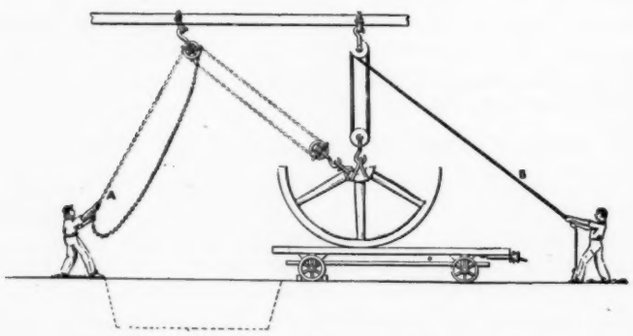


Fig. 4—Placing the flywheel in position

own, he made arrangements to use tools in the repair shop of a factory about a mile away. There was also a screw-cutting lathe which could be used for cutting and threading the largest sizes of pipe. The workman would make up little dimensioned sketches of a bunch of pipe, drive to the factory and fit up that lot of pipe, return and put it in place. Then another lot of pipe would be figured out and fitted in like manner. The workman "looked sidewise" at the hand-operated die stocks and after wrestling threads upon some 2-in. pipe, he allowed that cutting pipe threads was a "good deal like work." So, after removing both handles, he bolted the pipe-die stock to the faceplate of the lathe. A couple of distance blocks were placed between the faceplate and the die stock in order that there might be room to reach in behind and change the die.

While the engine and piping were being put into place by the two lone mechanics, men from a neighboring machine shop had constructed the mainshaft, its pulleys and hangers, and had erected them in the factory.

When the engine belt failed to track properly, the machinist foreman "put up a holler" that the steam engine had been set out of line, and no amount of reasoning could make him admit otherwise. The workman put up his line, plumb-bob and straight-edge and checked the aligning carefully and declared the engine was all right. But the foreman would not be convinced and claimed the engine foundation templet had been placed "out of line." The machinist foreman was invited to go over the whole thing again and check the alignment for his own satisfaction, while the crew checked the shaft alignment. In order to settle the matter for all time, it was decided to place a center line through the engine cylinder and square up the

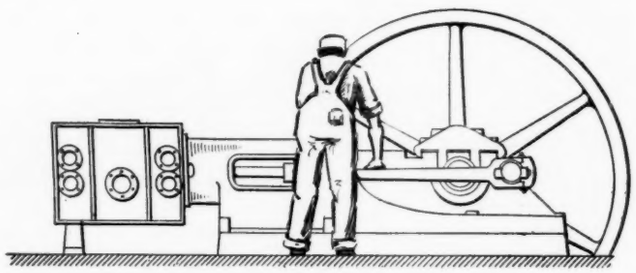


Fig. 5—Aligning the crankshaft

crankshaft to the center lines instead of to the crank head. But even then, as the big machinist was forced to admit, the shaft was absolutely "square with the world."

Pole measurements were then made from the base line to the lineshaft and there the trouble was found. The shaft was "out." Proper marks had been made, but the string had been fastened to a nail driven into a mark a few inches from the right one.

While all these things were troublesome at the time, when steam was finally turned on and the engine turned over, Jerry had to admit that as an engineer he "knew his onions."

In the Minds of Many Persons the sole cause of priming and foaming in boilers is high concentrations of sodium salts or other soluble compounds. This conception is not entirely correct, as there are ample data showing it possible to have high concentrations in boiler waters without experiencing this form of trouble. Foaming is caused by relatively high concentrations of soluble compounds when in the presence of a considerable quantity of finely divided suspended solids. Boiler construction has also a marked influence on the priming and foaming tendencies of boiler waters. Insufficient steam disengaging space and high steam velocity leaving the boiler are the more important design features causing these troubles.

Impressions of a Native Engineer in an Indian Power Plant

By P. P. TALATY

THE ill-informed picture a power plant in India as a tumble-down building filled with decrepit machinery. To the contrary, many Indian plants are modern in every respect, and the plant of which I had charge many years generated power for a cotton mill, with both steam and Diesel engines. The operating record of this plant, I say with all modesty, was equal to that of any corresponding American or European mill. In fact, the fuel consumption of the Diesel was better than that obtained in European tests.

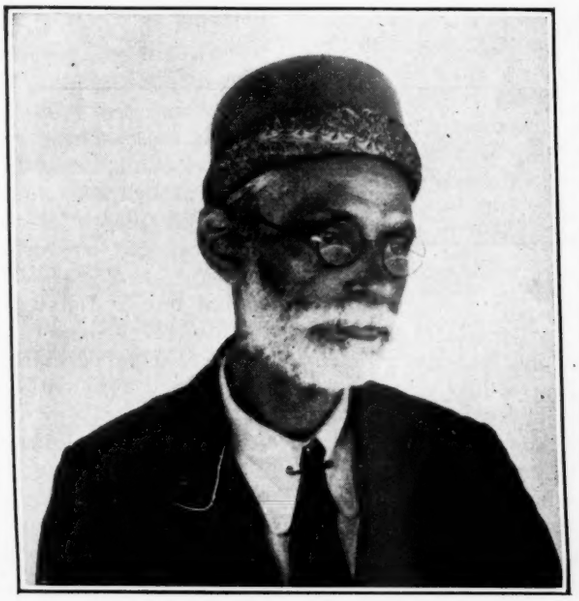


Fig. 1—The author in the Parsee ceremonial turban, he being a member of that caste, consisting of followers of Zoroaster

Europeans, and Americans too, feel that they have inherited all of the world's mechanical ability. As a consequence it is usual to import the engineer for tropical plants, and the native is permitted to do the more menial division of the labor. It is seldom, under such circumstances, that the latter has an opportunity to develop his latent engineering ability. For myself, events were more fortunate. I was able to expand my sphere of usefulness as I grew in knowledge of machinery, and I must announce that much benefit came from my reading of *Power*.

It may be true that tropical people are mere imitators, but in the line of my duty I have never hesitated to think a thing out for myself. After studying a situation, I have not been afraid to depart from the customary procedure. As an instance of this, I will cite adjustments made on the Diesel.

The European engineer who erected and first operated this 750-hp. engine, set the compression pressure and fuel-valve timing to give the indicator diagram shown in Fig. 3. First of all, a compression beyond 460 lb. is not advisable, and a fuel timing that will cause the peak pressure of 555 lb., as in Fig. 3, will injure all the working parts. This led me to lower the compression and alter the fuel-valve timing to give a diagram similar to Fig. 4. A reduction in fuel consumption from 0.72 to 0.64 lb. per kw.-hr. was the direct result. Nevertheless, the European received 2½ times my rate of pay, leading one to feel that some managers think that a heavily paid man must have the heaviest knowledge.

I find that most Diesel builders fail to take into account the hot sun-burning climate of the tropics. In India the temperature goes as high as 116 to 120 deg. F., while even 90 is considered high in the temperate zone. This makes the air density such that the hot-climate engineer cannot obtain much over 80 per cent of the engine's rating. Also the makers assume that the water-circulation conditions are similar to those in American plants. But in most parts of India, or say, the whole of India except near the Himalaya Mountains, the water temperature is high. I have ordered circulating pumps twice the usual size in order to hold down the cylinder-jacket temperatures. There is no economy in supplying such a limited amount of

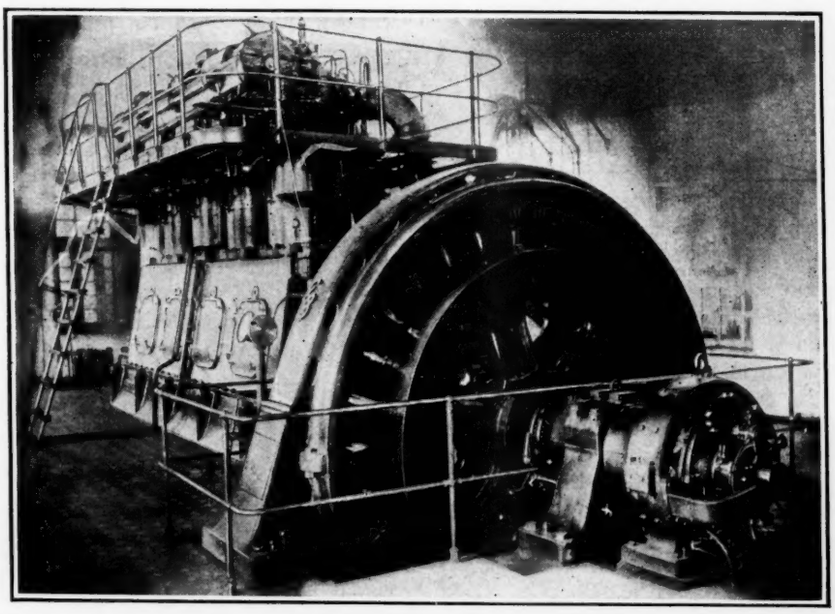


Fig. 2—View of engine room where the author was chief engineer

water that the temperature goes up to 140 to 150 deg. Never should the jacket discharge go above 110 deg. and the piston cooling water above 135 deg. F. In one case the engineer, in trying to reduce the fuel consumption, permitted the water discharge temperature to go high, resulting in piston freezing, ring carbonizing and breaking. As an excuse, he declared the lubricating oil to be bad.

One difficulty a native engineer meets in operating a

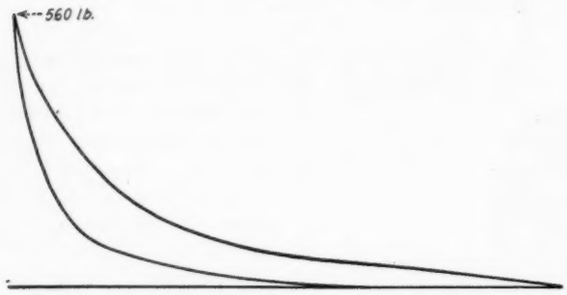


Fig. 3—Indicator diagram from engine as set by erector

strange piece of machinery is the lack of knowledge displayed by the representative of machine and oil companies. Most oil companies employ selling agents who claim to be experts in lubrication and praise their own oil, even though it be not suitable for the particular work, and condemn the oil of all other makers. The native engineer is at a loss to whom to turn. In addition, unscrupulous agents may offer a bribe or a commission. If the engineer cannot be influenced, the manager is approached. But the wise engineer, after deciding what is best, should be firm, even against the manager's wishes. For after all, the manager may not know what is best, and if a poor oil is purchased, only the engine suffers.

When one is satisfied as to the good quality of an old oil, I claim it is folly to change to another, regardless

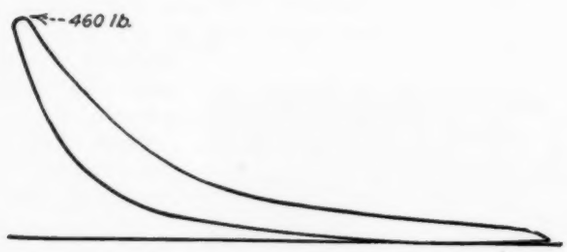


Fig. 4—Changes by engineer gave the diagram shown

of what claims a salesman makes, for there is a native proverb that "nobody is calling his mother a ghost." Much is said of the lubricating properties by the oil manufacturer, about viscosity, fire and flame test, but the engineer should bear in mind that the oil suggested by the manufacturer may be found too thick or too thin; it is the common protest against practically all of the best manufacturer's oils. I discarded the best manufacturers' recommended oil, in favor of a thinner-bodied oil of the same manufacturer.

I wish to emphasize the point that in spite of difficulties under which native engineers operate, Indian power plants are as efficient as American. The native engineer, likewise, is efficient, and this is especially true when one views the disadvantages confronting him.

Answers to What Do You Know*

Ans. 1—The 208,000-kw. General-Electric unit for the State Line Station of the State Line Generating Co., located on the Illinois-India state line.

Ans. 2—Equalization of cutoff of both valves of a Corliss engine is impossible at all loads. This is due to the angularity of the connecting rod and reach rods.

Ans. 3—In a steam-engine cylinder after cutoff the steam expands until the exhaust valve opens and allows the steam to pass into the condenser, where it is condensed. Inasmuch as the steam is condensed as fast as it leaves the engine, one cannot say that the pressure ratio is always indicative of the volume change undergone by the steam.

Furthermore, even if the steam was allowed to enter a large receiver where the pressure was maintained at 28-in. vacuum, what the volume would be at the exit from the cylinder would depend upon how the expansion took place. Assuming that the expansion was adiabatic, that is, work was done at the expense of the intrinsic energy of the steam, the problem could be worked out as follows: At 200 lb. gage or 214.7 lb. absolute the volume of a pound of steam is 2.14 cu.ft., and if it expands adiabatically its entropy will remain constant; consequently, at 28-in. vacuum, or 0.946 lb. absolute, the entropy of the mixture would be the same as at 214.7 lb., or 1.5399. If the steam at 28-in. vacuum were dry, its entropy would be 1.98, of which 1.8505 would represent the entropy of evaporation. The equation

$$\frac{1.98 - 1.5399}{1.8050} = 0.23$$

represents the portion of the mixture at 28-in. vacuum that has condensed into water during expansion; the remaining $1 - 0.23 = 0.67$ lb. of the mixture is steam. The volume of 0.67 lb. of steam at 26-in. vacuum is $350.8 \times 0.67 = 229.04$ cu.ft., and the 0.23 lb. of water has a volume of $0.23 \times 0.01613 = 0.0037$, which may be ignored. The ratio of expansions is, then, $229.04 \div 2.14, = 107$. If it had been assumed that the volume increased directly in proportion to the pressure decrease, the volume expansion would have been $214.7 \div 0.946 = 227$, obviously incorrect.

Ans. 4—Mercury, naphtha, hot air, ammonia, bisulphide of carbon, petroleum, nitrogen, sulphur dioxide, ether, diphenyl oxide.

Ans. 5—In most cases the water will weigh less than the boiler itself.

Ans. 6—The Oneida Street plant of the Milwaukee Electric Railway & Light Co.

Ans. 7—Theoretically, the character of media should have no influence on the power when operating between given temperature limits, but in practice there are differences, although slight.

Ans. 8—The fuel pump makes a stroke each revolution in most engines. This permits the engine to be governed quicker, inasmuch as the fuel handled can be altered on any revolution.

Ans. 9—Nikola Tesla.

Ans. 10—The heat will be increased due to friction through the valve, and the output will decrease. In most pumps this will decrease the horsepower input.

*The questions of which these are the answers will be found on page 8.

Automatic Boiler Blowdown in Proportion to Moisture Content of Steam

By W. J. HUGHES *

TOTAL moisture in steam generated by a boiler varies in amount directly with the load so long as the quality remains constant, tends to increase with high concentrations and decrease with low concentrations when the load is constant, and increases cumulatively with load and concentration. To maintain continuously the proper relation between boiler water condition and load, the author proposes to use, in addition to steam purification, automatic boiler blowdown, in proportion to the moisture in the steam, at a considerable saving over hand or continuous blowdown.

THERE are several factors that have a bearing upon the ability of a boiler to deliver clean dry steam. Certain types of boilers carry high loads with less violent circulation and steam liberation than other types. One type may perform with greater satisfaction with higher boiler water concentrations than others and therefore comes to be known as more favorable for bad feed-water conditions. Thus boiler design is a fixed factor, while the load on the boiler and the water conditions therein are variable. It is by means of the variable factors, of course, that control of boiler performance is effected.

Steam Quality Limits Forcing

To illustrate, assume first that into a certain boiler pure distilled water is fed. The manufacturer builds into this boiler a certain amount of heating surface on which he gives the boiler a rating. Under operating conditions, however, it is found that this boiler will deliver a quantity of steam equal to two or three times the manufacturer's rating, and do this with high efficiency. If the boiler is forced still more, or if the load is varied, the quality of the steam delivered begins to drop off, thus requiring that the load be limited.

If chemically impure water, instead of pure distilled water, is fed into the boiler, it will be found that in order to secure steam of usable quality, the load must be limited still further. Also it will be found that while quite high boiler-water concentrations may be permitted at low loads, greatly reduced concentrations must be carried at higher loads, hence, load limitation must be accompanied by control of boiler-water concentration. The latter is brought about by blowdown, but it is doubtful if blowdown is ever properly related to the actual boiler steaming conditions as economically as it should be.

The relation that should be brought about by blowdown is readily shown. For example, assume that a boiler operated at high load evaporates 1,000 gal. an hour and holds 2,000 gal. at normal water level. Assume further that the feed water contains 15 grains of foreign matter per gallon and that 300 grains per gallon is the permissible concentration that may be carried. Assume also that a 400-gal. blowdown is the most that is possible under operating conditions.

When it becomes time to blow down this boiler, it will contain 2,000 gal. of water concentrated to 300 grains per gallon. The total number of grains in the boiler water is 600,000. A blowdown of 400 gal. removes 120,000 grains, and 400 gal. of feed water to restore the water level in the boiler bring in 6,000 grains. The actual reduction is thus 114,000 grains, which leaves 486,000 grains in the 2,000 gal. of boiler water. The blowdown has thus reduced the concentration to 243 grains. When 114,000 grains are supplied by 7,600 gal. more of the feed water, the concentration will be up to 300 grains again, and the blowdown of 400 gal. must be repeated. Since the feed water enters at the rate of 1,000 gal. per hour, bringing into the boiler

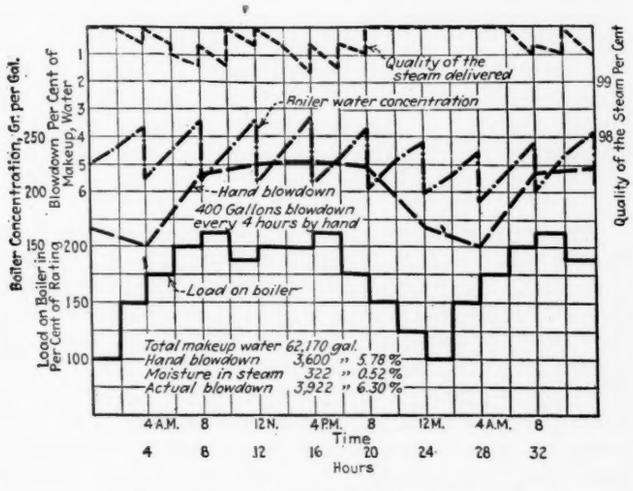

Boiler Concentration, Gr. per Gal.
Blowdown, Per Cent of Makeup Water
Load on Boiler in Per Cent of Rating
Quality of the Steam Per Cent
Quality of the steam delivered
Boiler water concentration
Hand blowdown
400 Gallons blowdown every 4 hours by hand
Load on boiler
Total makeup water 62,170 gal.
Hand blowdown 3,600 " 5.78%
Moisture in steam 322 " 0.52%
Actual blowdown 3,922 " 6.30%
4 A.M. 8 12 N. 4 P.M. 8 12 M. 4 A.M. 8
Time
4 8 12 16 20 24 28 32
Hours

Fig. 1—Routine blowdown by hand

15,000 grains each hour, this blowdown must take place every 7.6 hours. This is 400 gal. blowdown for 7,600 gal. of feed water, or 5.27 per cent.

In the foregoing example steam of 100 per cent quality was assumed. Such an assumption therefore ignores the moisture content of the steam, a condition that always exists to some extent. To carry the example to a point of greater practical application, assume that the quality of the steam has remained at 99 per cent with the variation of 243 to 300 grains in concentration. This means that 1 per cent of the boiler water has been removed with the steam, thus effecting the equivalent of a continuous blowdown through the steam nozzle. In the 7.6 hours between blowdown periods,

*Engineer, International Filter Company.

since the boiler has evaporated 7,600 gal., this steam nozzle blowdown amounts to 76 gal. containing an average of 271 grains per gallon. This is 20,600 grains, which may be deducted from the 114,000 grains to reduce the 400-gal. blowdown by hand. Thus the hand blowdown need be but sufficient to remove 93,400 grains, which at 300 grains concentration is 311 gal., or about 4.1 per cent.

The surprising fact is the enormous dry weight of

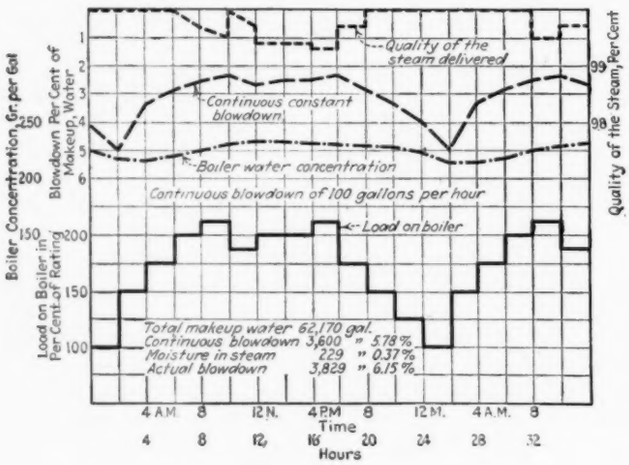

Quality of the steam delivered
Continuous constant blowdown
Boiler water concentration
Continuous blowdown of 100 gallons per hour
Load on boiler
Total makeup water 62,170 gal.
Continuous blowdown 3,600 " 5.78%
Moisture in steam 229 " 0.37%
Actual blowdown 3,829 " 6.15%
Boiler Concentration, Gr. per Gal.
Blowdown Per Cent of Makeup Water
Load on Boiler in Per Cent of Rating
Quality of the Steam, Per Cent
4 A.M. 8 12 N. 4 P.M. 8 12 M. 4 A.M. 8
Time
4 8 12 16 20 24 28 32
Hours

Fig. 2—Continuous constant blowdown

impurities carried by steam of fairly high quality. In the foregoing case, wherein the conditions described are not unusual, there are 20,600 grains of matter going into the steam lines every 7.6 hours. In round numbers this is 65,000 grains every 24 hours, or 9.3 lb. In 90 days this amounts to 837 lb., nearly a half ton. Further, if the concentration were doubled and the quality of the steam could be 99½ per cent, the quantity of dirt carried in the steam would still be the same amount.

Control Necessary with Varying Load

When boiler blowdown is regulated perfectly in relation to boiler output, steam quality can be fairly well controlled. But when the load on a boiler is varied, the control also must vary, otherwise the blowdown will be either too much or too little for actual operating conditions. The result is a waste of heat when blowdown is too much and a reduction in steam quality when it is too little. The operator who tries to blow down by hand in accord with the changing conditions under which boilers must deliver steam, finds himself in a dilemma. He must resort to a routine blowdown every so many hours whether needed or not. In addition he blows down the boilers between times if the need becomes dire.

Because of this situation, the need for steam purification has become steadily more urgent. Dirty steam is responsible for maintenance costs of sizeable proportions and wet steam does not beget high efficiencies in power generation.

Steam purification, at least, remains as one important step in correcting this condition, but, alone, it cannot reach the ultimate. The duty of a steam purifier is twofold. It must do all that the ordinary steam separator can do and considerably more besides. It is comparatively simple to build a device that will separate slugs of water from steam, but it is another problem entirely to build a device that will separate the finely divided moisture of 99½ per cent steam. This last problem involves what distinguishes the steam purifier from the ordinary baffled or whirligig separator.

Another important step in steam-quality control lies in generating steam of a quality that is at all times within the possibility of purification. Obviously, the installation of steam purifiers will not alone do away with the need for properly regulated boiler shutdown. The work done by the purifier and discharge trap consists merely of removing the impurities and moisture from the steam and discharging them into the blowoff sump. They are no longer to pass into the steam lines from the boilers. There is a need for proper blowdown to control concentration with purifiers, the same as without them, and if purifiers discharge back into the boilers, the need for blowdown is increased.

Quality an Index of Boiler Conditions

The fortunate fact is, that the quality of the steam generated is really a true index of boiler condition at all times. And the amount of moisture and impurities removed and discharged by the steam purifier is a direct measure of the quality or, inversely, the moisture. The following relationship should be kept in mind: The total moisture content of the steam generated in a boiler—

(a) Varies in amount directly with the load so long as the quality remains constant;

(b) Tends to increase with high concentrations and decrease with low concentrations when the load is constant, and

(c) Increases cumulatively with load and concentration.

Fig. 1 shows graphically how boiler-water conditions

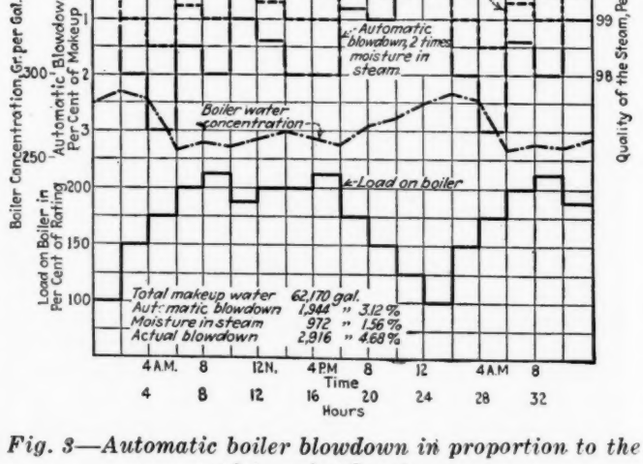

Quality of the steam delivered
Quality of the steam generated
Automatic blowdown, 2 times moisture in steam
Boiler water concentration
Load on boiler
Total makeup water 62,170 gal.
Automatic blowdown 1,944 " 3.12%
Moisture in steam 972 " 1.56%
Actual blowdown 2,916 " 4.68%
Boiler Concentration, Gr. per Gal.
Automatic Blowdown, Per Cent of Makeup
Load on Boiler in Per Cent of Rating
Quality of the Steam, Per Cent
4 A.M. 8 12 N. 4 P.M. 8 12 4 A.M. 8
Time
4 8 12 16 20 24 28 32
Hours

Fig. 3—Automatic boiler blowdown in proportion to the moisture in the steam

change within a boiler subjected to a varying load and a routine blowdown of the same amount every four hours. It will be noticed that the concentration tends generally to increase or decrease as the load increases or decreases. In other words, when the load is light the best boiler-water condition prevails, and when the load is high the worst boiler-water condition prevails. The result is poor steam quality at the times when the demand for steam is the greatest.

While it is true that during the peaks, when the quality of the steam is poorest, the tendency of the

wetter steam is to reduce the concentration, nevertheless the operator does not help out by a timely and proper blowdown. Routine blowdown does not call for the increases or decreases that are really necessary. The consequence is that a large amount of dirt is carried into the steam lines during the peaks. Another thing, these are the times when priming is more certain to occur.

It might appear from a study of Fig. 1 that the application of continuous blowdown would bring out materially improved conditions over hand blowdown. Fig. 2 shows what happens when continuous constant blowdown is applied to the conditions of Fig. 1. Improvement to the extent of removing the concentration high points, which occur just before each hand blowdown, is effected and this results in slightly better quality of steam generated.

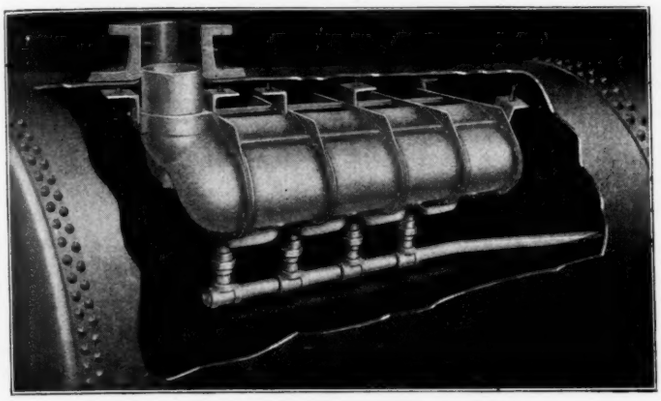


Fig. 4—Type of purifier used

The faults of hand blowdown, however, are present with continuous blowdown, as a study of Fig. 2 will indicate. Constant continuous blowdown, like hand blowdown, is too little for high loads and too much for low loads. The result is a too high concentration for the peak loads and a too low concentration for the low loads—just the reverse of what would be both desirable and more economical.

Continuous blowdown, if properly regulated, would bring about the desired conditions, but the matter of regulation is again the same problem of relating blowdown to actual boiler conditions. This problem cannot be solved effectively or efficiently by any sort of hand regulation by guess.

A more desirable boiler-water condition is a lower concentration for the peaks and a higher concentration when the load is light. It is this condition which can be brought about by automatic control, and, as is obvious, there will be a saving in the amount of blowdown. In addition a condition that tends to promote priming at peak load periods is corrected.

How Automatic Blowdown Is Accomplished

The methods and means for bringing about this control are simple, and this article is a disclosure on which patents are applied for. The method is best linked with steam purification. When a steam purifier of the type illustrated in Fig. 4 is installed in a boiler, the discharge of the separated moisture is at a rate that agrees with the moisture content of the steam. This separated moisture, which is laden with impurities, is conveyed to the exterior of the boiler, where it is discharged by a suitable steam trap of the piston-actuated variety.

As indicated in Fig. 5, the discharge valve of this trap is opened by a steam piston actuated by steam pressure admitted by a float-operated pilot valve when the trap chamber becomes filled. Since the filling of the trap chamber amounts substantially to a measure of the trapped moisture, it is obvious that the trap discharges will correspond to the amount of moisture removed from the steam by the purifier. Thus the number of trap discharges per unit of time will increase or decrease with the quantity and quality of the steam generated, or, that is, delivered by the boiler to the steam purifier. The pilot valve of the trap may be used, therefore, to open a separate piston-operated blowdown valve in unison with the trap discharges. And a needle or adjustment valve, also in the blowdown connection, can be set to proportion this automatic blowdown to the discharge capacity of the purifier trap.

If the adjustment is set so that the amount of automatic blowdown equals the discharge capacity of the trap, the total "blowdown" from both sources is twice the moisture content of the steam generated in the boiler. Thus if the quality of the steam generated is 99½ per cent, the total "blowdown" is 1 per cent; or if the quality drops to 97 per cent, the "blowdown" increases to 6 per cent, etc. The compensating effect of such proportionment is shown in Fig. 3, which gives the results of applying automatic blowdown to moisture content of the steam in a ratio of two to one in a boiler operated under the conditions assumed in Fig. 1.

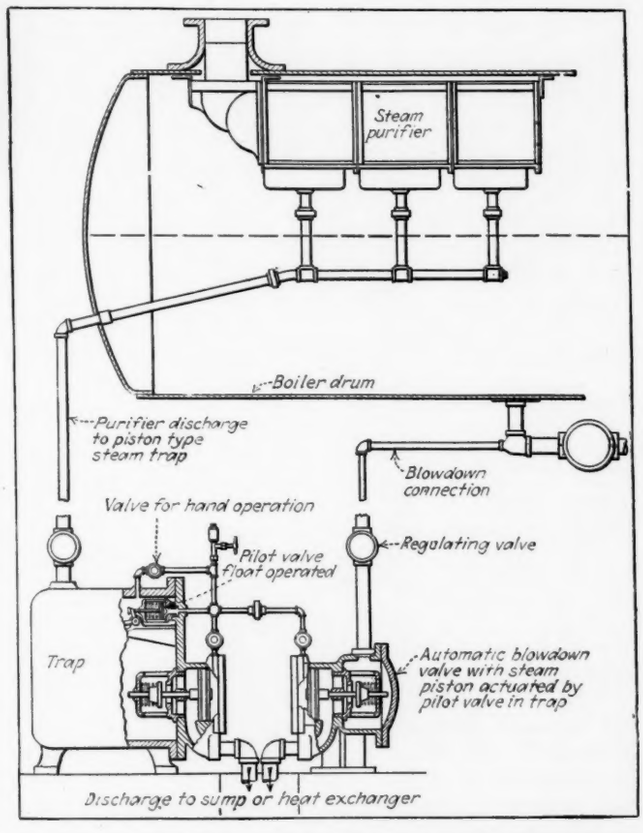

Steam purifier
Boiler drum
Purifier discharge to piston type steam trap
Blowdown connection
Valve for hand operation
Pilot valve float operated
Regulating valve
Trap
Automatic blowdown valve with steam piston actuated by pilot valve in trap
Discharge to sump or heat exchanger

Fig. 5—Purifier connected to automatic blowdown system using piston-actuated steam trap

Notice that in this case the concentration increases with light loads and decreases with the peaks; also that correction of the concentration comes about quite rap-

idly with changes in load. Comparison of Fig. 1 with Fig. 3 will make the differences plain. In Fig. 3, however, the curve showing the quality of the steam refers to that entering the steam purifier and not that leaving the boiler, as in the case of Fig. 1. The steam delivered, being purified, is at all times substantially 100 per cent dry and clean. Further, the condition of too high concentration at times of peaks, which tends to cause priming, is automatically corrected. Thus the purifier is protected from conditions that ordinarily would mean taking the boiler off the line; incidentally, the advantage is obvious.

The boiler operating conditions are given in Table I, which shows the quality of steam generated for various loads and boiler-water concentrations. These conditions were used as a basis for working out all three of the

TABLE I—STEAM QUALITIES FOR VARIOUS LOADS AND CONCENTRATIONS

Surface in boiler, 4,880 sq.ft. Load varies from 100 to 225 per cent of rating. Boiler holds 2,000 gal. at normal water level. Feed water consists of 50 per cent condensate considered pure, and 50 per cent softened makeup water containing 15 grams per gallon of total dissolved solids

Load Per Cent	Quality of the Steam Generated in Per Cent Boiler Water Concentrations in Gr. per Gal.										
	200	225	250	275	300	325	350	375	400	450	500
100	100	100	100	100	100	99.7	99.3	99.0	98.5	98.0	97.5
125	100	100	100	100	99.7	99.5	99.0	98.5	98.0	97.7	97.0
150	100	100	100	99.7	99.5	99.0	98.7	98.3	97.7	97.3	96.7
175	100	100	99.7	99.5	99.3	98.7	98.5	98.0	97.5	97.0	96.5
200	100	100	99.5	99.3	99.0	98.5	98.3	97.7	97.3	96.7	96.3
212.5	99.7	99.5	99.3	99.0	98.7	98.3	98.0	97.5	97.0	96.5	96.0
225	99.0	98.7	98.3	97.7	97.3	96.7	96.2	95.5	94.7	94.0	93.0

charts, in order that a fair comparison and better understanding of automatically regulated blowdown could be brought about.

Heat loss in blowdown by the three methods is given in Table II. The amount of heat saved by automatically regulated blowdown over the other methods will vary, of course, with the condition of the feed water. The total dissolved solids in the feed water, together with

TABLE II—SAVINGS EFFECTED BY AUTOMATIC BOILER BLOWDOWN AS SHOWN BY FIGS. 1, 2 AND 3

Total makeup water .....62,170 gal. in 36 hours
Actual blowdown by hand.....3,922 gal., 6.30 per cent
Actual blowdown continuous .....3,825 gal., 6.15 per cent
Actual blowdown automatic .....2,916 gal., 4.68 per cent
Heat loss by hand blowdown, av. per hour.....298,000 B.t.u.
Heat loss by continuous blowdown, av. per hour....291,000 B.t.u.
Heat loss by automatic blowdown, av. per hour.....221,700 B.t.u.

Saving of automatic blowdown:
Over hand blowdown, in per cent, 25.7; in heat, 76,300 B.t.u. per hr.
Over continuous blowdown, in per cent, 23.9; in heat, 69,300 B.t.u. per hr.
Over hand blowdown, in coal, per day, 261.6 lb.; per year, 47.7 tons.
Over continuous blowdown, in coal, per day, 237.6 lb.; per year, 43.2 tons.
Boiler gage pressure 215 lb., heat of liquid over feed: 330 B.t.u. per lb.

the concentrations that are safely permissible with a given boiler at different loads, will fix the amount of blowdown with almost mathematical precision. With feed waters of low mineral content the blowdown will be less in proportion, and with feed waters of high mineral content the blowdown will be greater. In the latter cases blowdown may amount to enough to make recovery of the liquid heat in the blowdown water well worth while. The trap and automatic blowdown discharges may then be passed through a suitable heat exchanger.

CARE SHOULD BE TAKEN that the sample of gas for analysis is an average sample. No hard and fast rules can be laid down for the methods of obtaining such average sample, and it is largely a question of common sense. The sample should be drawn from the main body of the gases at a location where the possibility of dilution through air infiltration is a minimum.

Unscrewing Rusted Threads

BY JAMES F. HOBART

The time-honored directions for loosening rusted bolt and pipe threads are, "Drench with kerosene and hammer well—". If that does not work, then try gasoline instead of kerosene, gasoline being far more penetrating. Bolts and pipes that are portable may be successfully treated by heating them in a blacksmith's forge fire, then hammering the nuts or fittings well and unscrewing them while hot. It may be well to wind a wet rag around the pipe close to the fitting, before applying the pipe tongs or wrench. In case the pipe appears to be weak and is dented by the tongs, apply less force to the tongs, but put on two or three pairs and thus distribute the pressure upon the pipe to a value where the metal will not be damaged.

When the pipe and fittings are stationary and cannot be taken to a forge or boiler furnace, one to three blow torches may be used with good effect. The direct application of a blow torch to a small nut or fitting will usually loosen the rust and permit of its being unscrewed. If this treatment fails, procure some charcoal and make a hole in a large piece in such a manner that the charcoal may be placed closely around the bolt or fitting that is to be loosened. If no charcoal is available, bore a hole in a piece of board or plank just large enough to pass easily over the nut or fitting. Then apply one or two blow torches to the nut, and in a short time almost a red heat will be obtained and the rust will be thoroughly broken.

Large fittings may require a little more wood or charcoal. Perhaps pieces of wood or coal may have to be piled all over and two or three blow torches used in the heating. For large fittings it may be necessary to have still more heat than two blow torches and the wood can furnish. In such cases procure a third torch and pump it up, but do not light it. When the charcoal or wood becomes burned and more heat is needed, then open slightly the gasoline valve of the pumped-up but not lighted torch, and throw a thin stream of gasoline into the wood or coal, at the point where more heating power is required. Fittings on 12-in. pipe may be heated almost to a red heat in this way. Be sure that a clean stream of gasoline is thrown by the unlighted torch. It may be necessary to remove a bit of scale or carbon from the nozzle of the blow torch in order to make it throw a clean stream.

If compressed air is available, throw some ignited oily waste upon the rusty fitting, pile on a little wood, place the nozzle of an air hose to play upon the fire, then pile on more wood, charcoal or bituminous coal, and in a short time the rusty fitting will be heated and the pipe can be backed out of its fittings or twisted in two.

When compressed air is not available, a small pipe may be run from the blower of a smith's forge, or from a blower or exhaust fan in the plant. The writer has used an ordinary desk ventilating fan to furnish blast for a soft-coal fire around a rusty pipe fitting. Should the pipe be in position above the floor, suspend a piece of sheet iron or a wide plank under the rusty fitting, put sand and bricks upon the plank, build loose brick side walls to hold the soft coal in place, then heat the fitting in the oven built around it.

Different conditions will require different treatment, but the foregoing suggestions should take care of most cases found in practice.

How To Make a Mercury Absolute Pressure Gage*

Absolute Pressure May Be Read Directly—Only One Instrument Required—Temperature and Other Corrections Eliminated

ONE of the most important and most difficult determinations made during a turbine test is the absolute condenser pressure against which the turbine exhausts. This quantity should be obtained with care and accuracy, as a small error in the absolute pressure causes a large error in calculating efficiency and in correcting results to standard conditions for comparison with guarantees. Ordinarily, two instruments are used for obtaining this data—the barometer from which the atmospheric pressure is read, and a mercury column, or U-tube, for measuring condenser vacuum. One end of the U-tube is connected to the condenser, and the other end is open to the atmosphere. Since the air pressure is greater than the condenser pressure, it pushes the mercury down in the open leg of the U-tube and up in the other until the weight of the mercury column *h*, Fig. 1, balances the difference between the atmospheric and condenser pressures. The height of the column *h* is the condenser vacuum in inches of mercury, and the absolute pressure is found by subtracting it from the atmospheric pressure as read from the barometer. Before this calculation is made, corrections must be applied to barometer and vacuum gage readings.

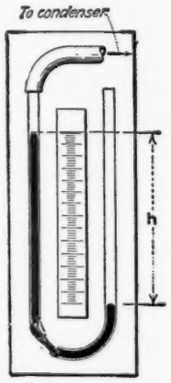


Fig. 1—Mercury vacuum gage

Like all other liquids the density of mercury changes with variations in temperature. Thus, if the mercury U-tube or barometer is in a hot room, it will require a higher column of mercury to balance a given pressure than would be the case if the mercury were cold. For this reason the barometer and the U-tube readings must be corrected to a common temperature, which is usually taken as 32 deg. F.

If the barometer and mercury U-tube are not at the same elevation, another correction should be made to compensate for the difference in air pressures at the two elevations. This correction is often considered negligible, but the following example indicates it should not be neglected: Assume the barometer is in the turbine-room basement and the U-tube on the turbine-room floor, the difference in elevation being 30 ft. The barometer will read about 0.03 in. Hg. higher when in the basement than it would if on the turbine floor, and this amount should be subtracted from the barometer reading before using it with the U-tube reading to find absolute condenser pressure. Obviously, if the U-tube and barometer are at the same elevation and same temperature, the correction becomes negligible.

To avoid these corrections and the necessity of reading two instruments the mercury absolute pressure gage may be used. This gage, as made by the Brooklyn Edison Co. Research Laboratory, is pictured in Fig. 2 and in general follows conventional design. One end of the glass tube is sealed off and the open end is connected to the condenser. The instrument is constructed so that zero pressure exists above the mercury in the sealed-off side of the tube, and thus the difference between the height of the mercury in the two legs of the tube measures the pressure in the condenser above zero and is the absolute condenser pressure.

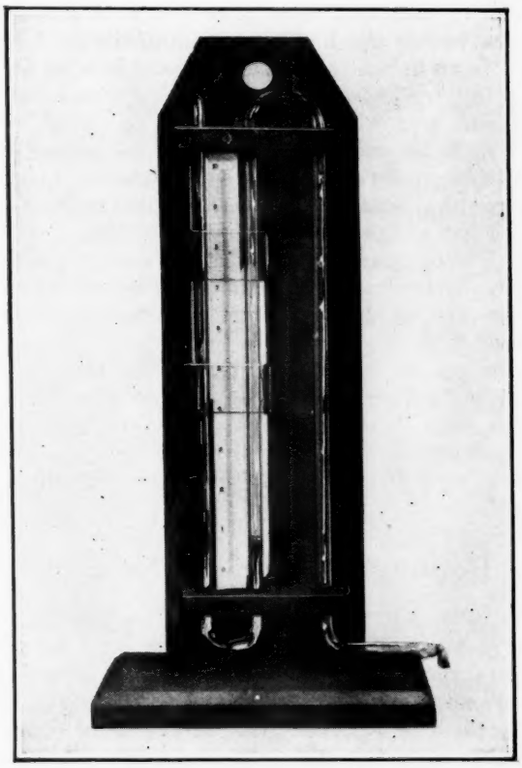


Fig. 2—Mercury absolute pressure gage

Readings from this instrument may be used directly without correction. As the unbalanced mercury leg is small, temperature corrections are negligible. There are only two precautions to be taken: First, water must not be allowed to collect above the mercury; second, the instrument must be vertical when reading.

The accuracy and success of the gage depends upon the degree with which all air, water and other vapors are expelled from the sealed leg of the tube. This was accomplished at the Brooklyn Edison Laboratory with a high degree of success by the following procedure:

*Information for this article furnished by W. F. Davidson and J. A. Duncan.

The tube, which is of Pyrex glass, is first made chemically clean. This is done by washing with an acid cleaner and acetone, and then heating in an oven at 600 deg. F. for a period of 24 hours to drive off all volatile vapors.

Dry clean mercury is then poured into the tube and boiled under atmospheric pressure.

Starting at the sealed end of the tube, the boiling is carried on progressively until all air and steam bubbles stop forming. The gage is then connected to a vacuum pump and the boiling process repeated several times at absolute pressures as low as 0.1 millimeter of mercury. The boiling process must be done slowly and carefully, as it will be found easy to crack the glass tube if heated too rapidly. It is to make this heating process easier that the tube is made of Pyrex glass. Rubber tubing must not be used to connect the gage with the vacuum pump, as at these low pressures the sulphur in the rubber distills off and contaminates the mercury. A successful glass joint was made by sealing with sealing wax.

The completed gage was checked with a standard McLeod gage capable of measuring pressures to 0.5 microns (0.0005 millimeter of mercury) and was found to check within the limits of reading the mercury column. As an indication of the degree of success attained in freeing the mercury from air and water vapor, it was found even when the gage was subjected to pressure as low as one millimeter, that the attraction between the mercury and the glass was sufficient to hold the mercury in the end of the tube until it was jarred free.

To facilitate use the gage is mounted on a well constructed wood frame with an etched white glass scale between the two mercury columns. Two sliders similar to those used on slide rules are provided to make reading easy.

The gage, as shown in Fig. 2, has been used on turbine acceptance tests and found to give consistent reliable results. After the tests the instrument was rechecked against the standard McLeod gage and its accuracy was found to be the same as when first checked.

Routine Calculations Reduced

BY L. G. JONES

The routine calculations necessary to prepare the daily performance report of a plant soon become tiresome to most engineers, and any kink to reduce or simplify them is welcome. One of the items contained in the daily report is the equivalent evaporation of the boilers as determined from readings of Venturi meters and a factor of evaporation made up once a week. The amount thus obtained is corrected for blowdown losses and meter corrections.

Since in the average industrial plant the blowdown, as well as other factors, remains fairly constant, considerable saving in labor and time may be effected by including these small correction percentages in an over-all factor of evaporation. To illustrate, assume the blowdown is 3 per cent, meter correction 2 per cent and factor of evaporation 1.2. The over-all factor of evaporation would then become $1.2 \times (100 - 3) \times (100 - 2) = 1.14$, which would be used seven times a week, while the foregoing calculation is made but once a week, and a saving of twelve operations per week has been made.

Parallel Operation of Direct Current Generators

When two or more direct-current generators are connected in parallel, the fundamental law for satisfactory operation requires that at the point where the generators are connected in parallel the voltage characteristic of the machines should be drooping. Furthermore, for equal division of load between the machines their voltage characteristics must be alike.

Where machines are of different ratings, load division in proportion to their respective capacities can be obtained if the voltage characteristicts of the machines are the same. For example, two machines *A* and *B* of 200- and 100-kw. rating respectively, are connected in parallel. If both machines are adjusted for a no-load voltage of 220, and then 150-kw. load is put on them, for proportional divisions of load machine *A* should take 100 kw. and *B* 50 kw. This division of load will be automatically obtained if the voltage of the two machines is the same at these loads. If the voltage of machine *A* is higher than that of machine *B*, it will take more than its share of the load. Or, if the voltage of machine *B* has a tendency to rise above that of *A*, it will take a larger proportion of the load than it should.

Shunt generators have drooping voltage characteristicts and are ideal for parallel operation. However, their voltage regulation is poor and they are not suited to most power loads. Compound generators, on account of their series winding, tending to cause the voltage to rise, offer certain difficulties in parallel operation, which are generally overcome by adjusting the voltage characteristics of each machine nearly alike and by the use of an equalizer connection.

On the non-interpole type compound machine the equalizer connection is made between the armature and series-field windings. On interpole compound machines the armature, interpole and series-field windings should be connected in series in the order named and the equalizer connection made between the series and interpole windings. This makes the interpole winding part of the armature circuit and it is therefore sure of having the same current in it that flows in the armature.

The forces that develop if correct provision is not made for the expansion and contraction of materials subjected to variations in temperature are large, their magnitude seldom being realized. To illustrate assume a wrought-iron bar having a cross-section area of 1 sq.in. and a length of 100 in., has been placed between restraining members that prevent any linear expansion. Thus if the temperature of the bar were raised, say, 10 deg., the material of which the bar is constituted would undergo a compression equal to the free thermal expansion of the bar due to the temperature rise. For wrought iron this expansion would amount to $6.48 \times 10^{-6} \times 100$ in. $\times$ 10 deg., or 0.00648 in. The force necessary to cause a compression of this amount may be found from the common formula $P = E\ a\ d$, in which E is the modulus of elasticity, a the cross-section area, d the unit deformation. Substituting in this equation, the force set up by this temperature rise is $P = 3 \times 10^7 \times 1 \times 0.648$, or 1,940 lb., and since the area considered was 1 sq.in., the stress in the bar is 1,940 lb. per sq.in. If the temperature rise had been 400 deg., the stress would increase to 77,600 lb. per sq.in., and something would probably break.

A Successful Block Power Plant

DATA on a Cincinnati power plant supplying light, heat and power to a block of buildings. During the summer months energy is purchased from a public utility and retailed

NOTWITHSTANDING a current belief that a plant supplying light and heat to buildings in a single block cannot be successful, the Edwards Building Co., Cincinnati, Ohio, is actually making a handsome profit in selling heat and power to such a group of consumers. The power plant, which is located in the basement under the rear part of the Edwards Building, was installed about thirteen years ago. At that time coal was obtainable at low prices and engineers' wages were far below the present standard. Efficiency was, as a consequence, not so imperative and a Watertown slide-valve engine direct-connected to 250-kw. 250-volt direct-current generator was installed. Increased load led to the addition of a 200-kw. and a 100-kw. generator direct-connected to piston-valve automatic engines.

During and after the War the soaring coal prices and the increase in labor losts proved to be serious handicaps to the plant's success. About this time a new management came into control and gave thorough study to the pressing problem. Obviously, the engines, satisfactory when coal was but $2 a ton, had become as burdensome as did the Old Man of the Sea to Sinbad the sailor. A proposition was made by an engine builder to install a uniflow engine on the foundations of the old Watertown engines, pressing the old generator rotor onto the new shaft. On a basis of 75,000 kw.-hr. being generated monthly, a guarantee was made that the new engine would save $825 a month. This was calculated on the basis of the then evaporation of 7 lb. per pound of coal with the latter costing $6.50 a ton. If this saving were possible, the building company figured that the engine would be paid for in approximately one year. The engine was installed and the balance after an initial payment was paid out of the coal saving. Owing to improvements in the firing methods the evaporation was raised to 8.3 lb., and by tests run after the installation of the new engine results shown in the table were obtained.

The reduction in steam per kilowatt-hour from that possible with the old engines was 30.9 lb., bringing about a saving of approximately 3.7 lb. of coal per kilowatt-hour, fully justifying the installation of the new unit.

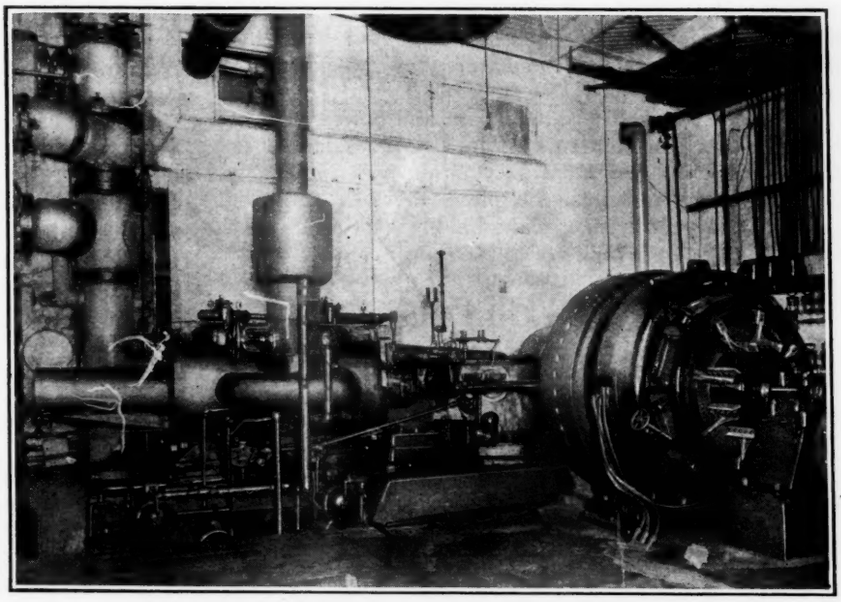
In 1925 a 3,000-sq.ft. horizontal water-tube boiler was installed alongside the older boilers, and in 1926 a 1,850- and a 3,000-sq.ft. boiler replaced the old units, whose settings were badly damaged and whose tubes were so corroded as to require renewal if the boilers were to be kept in service.

Each of the three new boilers is equipped with overfeed side-retort stokers, all driven through a jackshaft by a single direct-current motor. While the boilers were designed for 160 lb. working pressure, 135 lb. is usually carried.

TEST OF UNIFLOW ENGINE

Size of engine, bore and stroke, in.	22x24
R.p.m. on test	175
Rating of unit, kw	250
Duration of test, hours	5
Load by wattmeter, kw., average	115.6
Indicated horsepower, average	198
Steam pressure at engine, lb. in sq.in.	139.6
Back pressure, lb. per sq.in.	0.5
Total water evaporated, lb.	4,320
Total coal fired, lb.	520
Feed-water temperature, deg. F.	105.8
Water evaporated per kw.-hr., (including boiler and line losses), lb.	37.5
Water evaporated per i.hp.-hr. (including boiler and line losses), lb.	21.7
Evaporation, lb. steam per lb. of coal as fired	8.3

In addition to the lighting and heating load, steam is supplied to simplex compound hydraulic elevator pumps and to the house service and vacuum pumps.



New engine was direct connected to old generator

The heating season begins October 1 and continues for 7 months. During this period the uniflow engine is run from 7 a.m. to 12 midnight, exhausting at 1 lb. into the heating mains. The returns are handled by the vacuum pump, which maintains a 12-in. vacuum in the condensation lines.

Owing to variation in temperature the amount of steam heat needed by the customers varies over a wide range, even in a single month. It is highly desirable for the plant to have a steady relatively fixed income, and this led to selling the steam heat on a basis of 45c. per month per square foot of radiator surface served. The rate is based on $5 coal, with a reduction or increase of 1c. per sq.ft. of radiation for each 25c. change in the price of coal. At present coal is delivered to the

boiler room for $4 a ton and about 13 tons is used daily. To those who need live steam for processing, high-pressure steam is sold at $1 per thousand pounds.

The load during the day is fairly constant, with a peak at 5 p.m. when the growing dusk prompts the use of more lighting in the stores and offices. After midnight the lighting load is small, which permits the shutting down of the uniflow and the using of the 100-kw. piston-valve unit. As the plant has a breakdown connection with the local public utility, this service is used up to the minimum of 50 kw-hr. a month. The total daily output ranges from 3,000 to 3,200 kw.-hr., and very little live steam is needed in the heating lines.

As soon as the heating season is ended, the engines are shut down and the building company draws its supply of electrical energy from the public utility lines and retails it to its customers. Under conditions existing in most cities this energy could not be purchased save at a high rate, but the plant is able to purchase its summer's supply at the rate covering all-year service, and owing to this low rate the plant cannot generate during the summer as cheaply as it can purchase the power. The boilers, however, are kept in service to supply the limited amount of live steam to certain customers and to the elevator and service pumps.

The force consists of a chief engineer, an oiler, two watch engineers and three firemen. Shifts are of 8 hours' duration, and the union scale of $1 per hour for engineers is paid, making the weekly wage total $325.

The income from the sale of heat and power is $5,000 a month and the building's debits for the same service are placed at $900 a month. On this basis, and after deducting fixed charges, the plant shows a net profit of $12,000 a year with a plant having a present worth of approximately $75,000.

Notes On Oil Firing

By Roland L. Tullis

Firing boilers with oil presents problems not existing in coal-fired plants. Leaky valves, water in the oil, wet atomizing steam, poor piping, etc., may cause trouble to an engineer who has been trained in a coal-burning plant.

I once took charge of a hospital power plant where the former chief engineer had resigned because he was unable to make the oil-burning system work. The boilers were fired with natural gas most of the time, as the management had secured a low rate under contract, but in extremely cold weather the gas mains were not large enough to supply the abnormal demand. Consequently, at such times it was necessary that the power plant be able to burn oil on short notice.

The service tank, which was situated in an alley back of the power plant, was a cylindrical steel container of about 50-bbl. capacity, with an open manhole in the top. The top was about three feet under ground, but the manhole extended up to the surface of the street, where it was covered with a loosely fitted cast-iron plate. Apparently, the alley graded toward the manhole cover, for the tank was found to be about one-third full of rain water. As no provision had been made for removing the water from the tank, it was necessary to install a suction-pump line.

It is good practice to have two suction lines in every oil-service tank if uninterrupted service is required, as all fuel oil contains some water which will gradually settle to the bottom and will eventually fill up and reach the oil-pump suction; water will be pumped into the burners, perhaps causing a shutdown.

Any great amount of water in the fuel oil will often cause serious trouble; even a spray of water passing through the burners will extinguish the fires. This is often followed by a spray of oil which will volatilize from the heat of the furnace and suddenly explode, sometimes causing the boiler setting to give way, and many firemen have been injured from this. If the fireman is close by and quickly closes the oil valves to the burners, the danger is avoided. However, the best safety and trouble insurance is to keep the water out of the burners.

Water in the oil was only one of the troubles with the oil-burning system in the hospital plant. After this situation was cleaned up, we found that there was a great deal of water in the steam used for atomization. This is almost as serious as water in the oil and has a somewhat similar effect. A slug of water in the steam will sometimes extinguish the fires or at least cause poor atomization of the oil, resulting in poor quality of flame and consequent low economy of operation.

Tracing back the steam lines from the burners, we found that the pipe was connected to the bottom of a long branch line which gave an excellent chance for condensation to collect. Therefore, the steam line to the burners was changed and the supply taken off the boiler domes. Dry steam is necessary for the successful operation of oil burners using steam for atomization.

Next we found that the oil was not heated properly, and so an up-to-date oil heater was installed. This used the exhaust steam from the oil pump to give the fuel the proper temperature, which we found to be 160 deg. F.

Unfortunately, our troubles were not yet solved completely, for the burners would not operate satisfactorily. They would stop up too often, and the oil had a tendency to drip from the tips of burners. The strainer on the oil line was found to be a small single strainer, and it was impossible to clean it while the burners were in operation. Examination showed that the strainer screen was too coarse and allowed the passage of foreign matter of sufficient size, to plug up the burners. Therefore, twin strainers with fine-mesh screens were installed in both the oil and steam lines to the burners.

Another mistake found was that some inexperienced person had installed ordinary globe valves for the regulation of the oil feed. It is impossible to regulate the flow of oil to a burner with a globe valve, and even needle valves are not satisfactory, as they have a tendency to stop up too easily. A special oil-firing valve should be used where the fires are manually controlled. These valves use a V-shaped opening in the disk or plug, through which the oil passes. They are easier to regulate, give finer adjustment and are less liable to stoppage.

The life of a burner will depend to a great extent on the effectiveness of the strainers, hence no point should be overlooked in making the latter as efficient as possible. The indications of dirty strainers are lag in oil flow, white smoke at the stack and abnormal rise in the pump pressure.

Cleaning strainers in general is necessary every 24 hours. The frequency, however, should depend entirely on experience, and no definite time limit should be set if the oil carries a high percentage of dirt or sediment.

International Standardization

ENGINEERING circles have been ruffled by the discussion of international standardization.

Not that there is any pressing need of international negotiation upon the subject, but because there are two groups seeking to be delegated to the task.

Out of the International Electrical Congress held in connection with the St. Louis Exposition of 1904 there grew the International Electrotechnical Commission, of which Lord Kelvin was the first president. It has dealt for the most part with electrotechnical questions, and its United States constituent, the United States National Committee of the International Electrotechnical Commission, has been sponsored and largely supported by the American Institute of Electrical Engineers.

At the World Power Conference, held in London in 1924, the information concerning the water-power capacities of the participating countries was presented in so many different terms that the desirability of an internationally uniform system of rating rivers and hydraulic resources was manifest. During the discussion of a proposal to appoint a committee for this purpose, President Semenza of the International Electrotechnical Commission said that his commission had already issued a report upon the subject and suggested that the matter be turned over to them. This was done with some informal remarks about the possibility of the Electrotechnical Commission being broadened in constitution and title to extend its activities to other than electrical subjects.

At its meeting in New York in April of last year the Electrotechnical Commission considered steam as well as hydraulic turbines, but had no committee at work on the general subject of water power.

In the meantime the American Engineering Standards Committee had appointed a committee on the Rating of Rivers.

At the same time, but independent of the I.E.C. meeting, a proposal was brought to light which had been brewing among the standardization bodies of the various nations, most of them constituents of the I.E.C. —a proposal to form an international standards association by the federation of the national bodies.

The subsequent disturbance has been caused by the efforts of the standardization bodies to secure approval of their constituent and supporting organizations to their participation in this projected international body and by the remonstrance of the International Electrotechnical Commission to being reduced to the minor rôle of the electrical panel of such an organization, and its efforts to adapt itself to its widened scope.

There appears to be no crying or imminent need for international action on standardization.

True, we want to think in the same terms, define things in the same way and work to the same specifications.

The world is getting too small, communication too easy and exchange too general for industry and commerce to be bothered by a lot of conflicting measurements and practices.

But each nation has a pride in the ideals that it has developed and is set in the practice that it has adopted.

It makes no difference how many national standards there are *if they are all alike.*

The real task and opportunity of the various national standardization bodies is to work with similar bodies in other countries in the making of their standards; and, by consultation and comparison of their studies in the formative stages, arrive at results that are the best that their collective knowledge and experience can evolve. This will result not in a collection of international standards, but in a uniformity among the standards of the different nations and harmony and solidarity in the profession and industry, without surrender of national autonomy and prestige.

It does not require the organization of another international body, with its secretariat and budget and passing of the hat and periodical transatlantic foregatherings, to do this. Continuous co-operation among the national bodies rather than the injection of a new international body is apparently the most promising path of progress for the immediate future.

More Practical Information Needed on Packing

PACKING has been used almost as long as joints under fluid pressure have been in use, but in many applications the kind of packing to employ is open to question. This fact is one of the conspicuous features of a recent report on packing for hydraulic machines issued by the Hydraulic Power Committee of the National Electric Light Association. In about fifty per cent of the applications on waterwheel shafts, in thirty-seven plants, some kind of flax packing is used, while in the other fifty per cent twelve other kinds are used. In two plants water or grease seals are used instead of packing.

Another striking feature of this report is the range of three months to over five years given for the life of packing. Even for the same kind of packing the life varies from six months to three years. The condition of the shaft in contact with the packing is given as being "excellent" to "badly worn." Some operators are specific as to the kind of packing they consider the best, while others feel that they have not found one that is entirely satisfactory. Although flax is the most generally used, it is not always with satisfactory results. This is also true of some of the other types of packing that are not so generally used.

These conflicting results indicate that there is room for a careful study of this problem. Packing apparently is one of those incidents in power-plant operation that

everyone has attempted to apply in his own way, little attention being given to why one kind gave better results than another or what were the contributing elements in long life and satisfactory operation. Where packing is used in a stuffing box on a moving shaft, the human element is an important factor in its success or failure. A packing that is ideal for the service can be made a complete failure by the condition of the shaft or by the way it is installed. Even after it has been installed properly, lack of lubrication or improperly adjusted glands may cause short life of the packing and also a badly scored shaft. On a waterwheel shaft the quality of the water may also be a factor. Grit carried out along the shaft with the water will cut the shaft and the packing.

The fact that two plants are operating with seals, one water and the other grease, instead of packing, and each reporting satisfactory results, raises the question as to packing being the final solution to the problem. The cost of packing and its installation may be a small part of the cost of operating a power plant, but if a large shaft is badly scored and has to be put back into condition again, the expense becomes something well worth considering.

Although this report does not give anything definite on which to base a selection of packing, it does show that more consideration should be given to this feature of plant operation. If one shaft can be packed to last for over five years and the shaft remains polished, where in another installation the shaft is badly cut and requires packing at the end of six months, it is evident that a further study of this problem may be productive of economic results.

Coal Carbonization

A FEW years ago references to coal carbonization generally consisted of a description of some proposed process and a discussion of its technical advantages. Of late there seems to have been a change in point of view. In several recent papers discussing the economies of the low-temperature carbonization as compared to high-temperature, the authors have endeavored to show that certain processes may be profitable on account of the sales either of the byproducts or of the semi-coke.

The value of the low-temperature byproducts seems to be fairly well known, and the yields from the various coals on the different processes have also been demonstrated. Hence, the income from this source can be estimated fairly well, depending on local conditions and on the utility of the gas produced.

There is a growing impression that the development of several low-temperature processes has progressed sufficiently in America to show that the technical difficulties have been or can be overcome. This would indicate that the commercial operation of these processes is possible in the near future. At present the assumed costs of plant and of operation must be rough estimates and, as in all new developments, will probably be considerably lower than actual costs in the first plants. However, if one may judge from past experience in the development of other utilities, later installations will be cheapened and simplified so that lower first costs may be possible.

The financial success of many low-temperature processes will depend on the market value of the semi-coke for domestic purposes. It is proposed to sell this smokeless fuel as a substitute for anthracite. Its desirable properties of cleanness and freedom from smoke should warrant a higher price than for raw bituminous coal. But how closely can this price approach that of anthracite? This will depend on the locality where it is offered for sale.

Where consumers have always been accustomed to anthracite, they will be ready to pay a reasonably high price for the new fuel to take its place. In the Middle West, however, bituminous coal and low-priced oil fuel are commonly used. It is evident that considerable educational efforts must be undertaken to induce consumers to turn to the higher priced semi-coke. Much creditable work of this character has been done by the gas companies in promoting the sale of high-temperature coke from their gas plants. Those who have tried the new semi-coke from low-temperature plants report favorably on its use.

The High Cost of Free Engineering Advice

ONLY a few rides in a street car or commuter's train are needed to convince one that mankind loves to give and receive free advice. Whether it be legal, medical or physical-culture treatment the patient needs, his friendly seatmate, after the ice of aloofness is broken, is eager to advise fully as to his legal rights and medical ailments.

The habit of giving and of accepting free engineering advice leads to duplication of effort and multiplied expenses, all of which must ultimately be paid for by the general public. Recently, a flour mill that was using purchased energy decided to look into the matter of installing its own power plant. Instead of engaging a consulting engineer, the management notified various manufacturers of power equipment of its willingness to discuss the matter. Each of these builders sent an engineer to investigate the mill's load-operating schedule, output and other details necessary to know in formulating an engineering report. As this was not merely a case of quoting on a machine, but involved engineering the job, the time spent by each sales engineer mounted up until the total expense of the investigations made by all the machine builders was greater than the profit of the fortunate bidder if the mill had been actually installed in the plant.

But no new plant went in, for the calculations of the sales engineering were used to force the electric-transmission company to lower the mill's rates.

How much assistance a factory can justly ask of machinery builders in its attempt to obtain lower electric rates is problematical. True, it got something for nothing, but the cost eventually was distributed among those who did buy. Nothing need be said of the absence of candor in the mill's dealing.

The question to be answered is, Who is to be blamed? Manufacturers cannot be criticised for seeking to develop business by showing prospects the savings possible through new equipment. Nor can the mill owner be blamed for lending an attentive ear. Possibly the solution would be for a group of engine builders who are working on a job, to appoint one sales engineer to work up the problem, results of which could be used by all the bidders. The prospect or the machine manufacturers could engage a consulting engineer. Certainly, either plan would be immeasurably cheaper than the present custom.

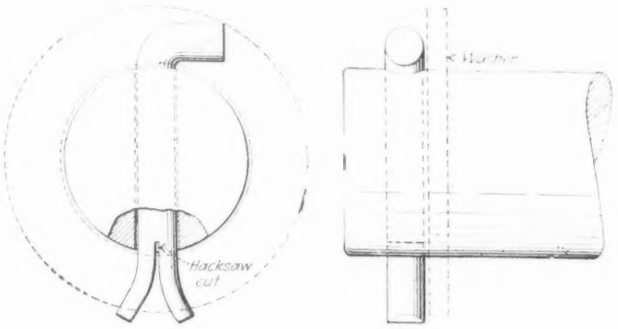
Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Large Cotter Keys Made from Round Iron Rod

Large cotter keys are seldom handy when one wants them, and frequently rather impractical substitutes are used.

A practical large cotter key up to ½ in. can be quickly made of the body of a bolt or piece of round rod as shown in the illustration. The tail is split with a hacksaw only a little farther than the edge or face of the



Large cotter pin made from a piece of round rod

rod it is spread against. Most any iron rod will stand a right-angle bend in the vise without fracture to make the head.

Such a key is much easier to punch out after it rusts in, and it will cover a washer and hold it as well as the standard pressed keys. F. BENTLEY.

Missouri Valley, Iowa.

Dirt on an Exhaust Fan Caused Unbalancing

An exhaust fan which delivered shavings and sawdust to the boiler room of a wood-working plant and which had run quietly for a number of years, began to give trouble by rattling badly and by cutting out the soft-metal lining of its journal bearings. Finally, the blower was removed preparatory to its being scrapped and a new one installed in its place. I chanced to see the runner after it had been removed from its case, and placed its shaft on the balancing ways. The runner was found to be badly out of balance and required the application of more than a quarter-pound of metal to one of the fan blades to approximate a standing balance.

Thinking that a balance weight might have been lost from one of the fan blades or arms, some scraping was done on them, with the result that more than a pound of pitch and dirt was removed, after which the runner was found to be in balance.

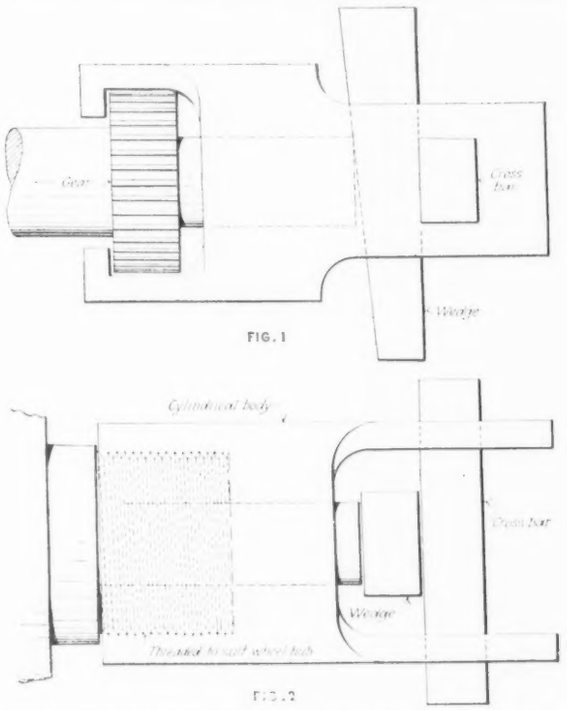
Another new set of soft-metal linings were poured into the bearings, and when the blower was put in service again it ran as smoothly as when it was new. I have occasionally found the same trouble prevailing in portable ventilating fans, which rattled so badly that it seemed as if new bearings were an immediate necessity. A careful cleaning of the fan blades, arms and armature, often resulted in complete quieting of the objectionable rattle. JAMES F. HOBART.

Indianapolis, Ind.

Wedge Puller, for Removal of Gears or Pulleys

A type of gear puller which employs a wedge instead of a screw, is shown in the accompanying sketch.

For use with small gears the puller is made with a cylindrical body and with slots for a crossbar. The pulling end is fitted with lips to engage the gear, as shown in Fig. 1. The wedge is placed between the crossbar



Figs. 1 and 2—Wedge type puller for gears with plain and threaded hubs

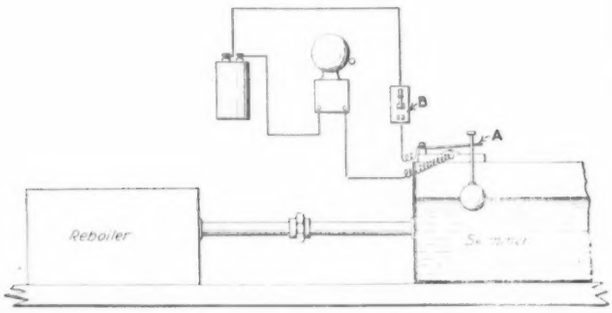
and the end of the gear shaft. The body of the puller is made from a steel cylinder or a piece of steel pipe.

For removing a wheel that has a threaded hub, an inside thread is made at the puller end instead of providing lugs. The puller is screwed on and the wedge is driven between the crossbar and the end of the shaft, as illustrated in Fig. 2. G. A. LUERS.

Washington, D. C.

Reboiler Water Level Alarm

During warm weather ice engineers may be so busy that they do not have time to write about their troubles, but they have them just the same. One trouble that is experienced is that of the reboiler getting too low, which permits air to get into the filtering system. Although various arrangements of floats, telltales, automatic shutoffs and other devices are used to prevent the reboiler from getting too low, they do not always work. The illustration shows a device that has not



Arrangement of water-level alarm

failed to function since it was installed several years ago.

It consists of an ordinary dry battery, an electric bell, a push button and a small switch. In this instance the bell and dry battery are placed in the engine room. A float operates the push button when the water in the skimmer is reduced to a level indicating that it is getting too low. With low water the weight of the float, assisted by the stop piece on the top end of the float stem, brings the arm *A* against the push button, thereby making a contact and causing the bell to ring.

This warns the engineer to remedy the water level. The switch *B* is used to prevent using up the battery any faster than is necessary, and as soon as the bell rings the switch is thrown to the open position, and is thrown in again after the water has been brought back to its normal level. H. J. MULLINS.

Birmingham, Ala.

Installation of Flexible Coupling Cures Motor Trouble

Slip rings, such as used on alternating-current machinery, have a continuous surface of conducting material and might be expected to give very little trouble by sparking at the brushes. In general this trouble may not be as prevalent as at commutators and brushes; nevertheless, it is frequently the cause of considerable difficulty in the operation of motors and other equipment.

Sparking at slip rings results from a number of causes, such as vibration due to the rotor being out of line or the motor not properly lined up to its load; slip rings out of round; material in the rings not of uniform quality, so that flats spots wear on them; brushes sticking in the holders and making poor contact with the rings; rings trued up at slow speed but when running at high speed distorting out of round, either on account of centrifugal force or because, as the rings' temperature changes, their mountings do not allow them to expand uniformly. In addition to these troubles there are those due to conducting dusts collecting on the rings' insulations and causing flash-overs between the rings.

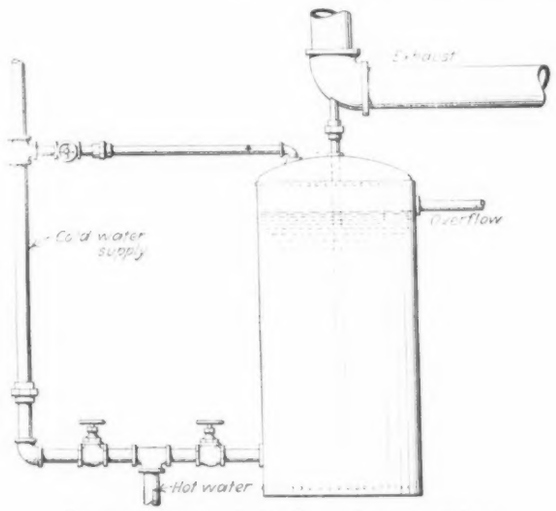
In the plant where I am there is a large centrifugal pump driven by a slip-ring motor running at a speed of 1,750 r.p.m. Every three or four months this motor had been giving trouble due to the rings and brushes arcing and breaking down the insulation between them.

Grouting the bedplate of the motor and pump to the foundation was tried without relieving the trouble. Checking the alignment of the pump and motor was also tried, but without improving conditions. It was then decided that there was not enough end play in the rotor shaft to allow the revolving elements of the pump and motor to center properly. The coupling was removed and about $\frac{1}{8}$ in. play was found between the end of the motor and the pump shaft. About one inch was cut off the motor shaft and a flexible coupling installed. This was over a year ago and since that time no trouble has been experienced with the motor or pump. J. B. WILLIAMS.

Seattle, Wash.

Simple Arrangement for Heating Water with Exhaust Steam

I recently came across an arrangement whereby the engineer had rigged up a connection for heating wash water with exhaust steam. A tank having a capacity of about 30 gallons was arranged as shown in the illustration. On the top end of the tank a $\frac{1}{2}$-in. pipe was fitted, the lower end reaching nearly to the bottom of the tank. The upper end of the $\frac{1}{2}$-in. pipe screwed into the ell of the exhaust pipe running from the engine



Arrangement of tank and connections

to the atmosphere. A cold-water supply pipe also connected to the top of the tank for the purpose of replenishing the water supply as required.

From the bottom of the tank a $\frac{3}{4}$-in. pipe connection was made, with a valve, as shown, and a short piece of pipe which screwed into a tee. The opposite end of the tee was connected to a cold-water supply, and the side outlet was piped to a point above the sink. With this arrangement, when water was required, either cold, hot or an intermediate temperature water could be obtained by regulating the valves.

Columbus, Ga. D. W. CLARK.

Comments from Readers

Twenty Years of Standardized Boiler Construction

"Twenty years ago, on July 5, the late Joseph H. McNeill had a very good idea. This idea made McNeill, then Chief Inspector of the State of Massachusetts, Boiler Inspection Department, and later Chairman of the Board of Boiler Rules, the father of standardized boiler construction which has reduced disastrous boiler explosions almost to a minimum and which should, in the next ten years, reduce them to the absolute minimum; there will be some old, non-standard boilers in use in the United States for about ten years more.

In the reports of the insurance companies we find records of boiler explosions, and once in a while there are serious and disastrous explosions, with attendant loss of life; but at the present time most of the so-called boiler explosions reported by the insurance companies and others, are really in effect boiler derangements or boiler defects, most of which could be eliminated or would have been eliminated if the operators had been careful.

However, be the explosions as they may, we are headed in the right direction and are almost free from disastrous holocausts in the way of boiler explosions. Further, some explosions are from boilers not yet under state, insurance company, or governmental control, but the laws are fast being made in the different states covering pressure vessels of every name and nature. This, of course, is the ultimate idea of the standardization of boiler construction in the United States.

Boilers built in conformance with the standards cost only 10 to 20 per cent more than non-code boilers and can be used at least 40 years if properly cared for.

During this vast amount of work and the vast amount of counsel and advice to boiler manufacturers, boiler users, insurance companies and others interested in steam generation, Joseph H. McNeill stands out, in the writer's judgment, pre-eminent as the father of them all, and it is too bad that he could not have lived to see the fruition of his thoughtfulness, patience and fortitude in starting this great work.

I might further add, as I have at ten, sixteen and this, the twenty-year article on boiler explosions, that we were given—especially in the Massachusetts Board of Boiler Rules and the Boiler Code Committee of the American Society of Mechanical Engineers—every cooperation from the great interests manufacturing and using boilers.

Most of the readers of *Power* know all about standardized boiler construction and the safety carried with it, but reiteration and repetition for the necessity of more careful operation of steam boilers and their accessories never come amiss with the rising generation. In other words, in 1830, nearly one hundred years ago, one of our most eminent engineers stated that boiler explosions were preventable. By this he did not mean boiler derangements or boiler defects, such as the failure of tubes, headers, or accessories. These minor accidents will always take place and probably a few people may be maimed or possibly killed, but the days of great boiler eruptions, the tearing to pieces of factories and the killing of great numbers of people, are over in the United States of America.

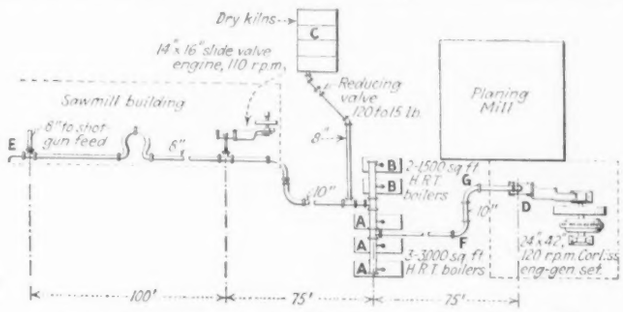
JOHN A. STEVENS.

Lowell, Mass.

Why Do the Boilers Shake?

I should like to submit the following problem to readers of *Power* with the hope that I may get some light on the cause of the trouble and how to correct it.

For some time we have had trouble with the three 3,000-sq.ft. horizontal return-tubular boilers marked *A* in the illustration shaking badly from time to time. *D* is a 24x42-in. double-eccentric Corliss engine-generator set driving the planing mill and all the sawmill except a gang saw, which is driven by the small slide-valve engine shown. At the far end of the sawmill building at *E*, steam is furnished to the shotgun feed for the log



General arrangement of boilers and engines with interconnecting piping

carriage. This is an 8-in. line with an expansion bend as shown. This line is well supported and no vibration is noticed on this pipe. From the connection to the slide-valve engine back to the boilers the line is 10 in., also well supported. An 8-in. line is taken off close to the main boiler header to supply steam to a battery of dry kilns. This line has a pressure-reducing valve at the kilns, reducing the pressure from 120 to 15 lb. The Corliss-engine-generator set has a 10-in. line as shown, but this line makes about an 8-ft. drop in elevation from *F* to *G*, the boiler headers being that much higher than the receiver separator on the Corliss. No vibration is noticed on this receiver when the boilers *A* are shaking. There are also a few small lines taken off the header for boiler-feed pumps, small lighting engines, and other accessories.

These boilers all have Dutch-oven furnaces for burning mill refuse and were all erected strictly according to the manufacturer's specifications, which is the usual I-beam column supports and channels across the top. All brickwork is in excellent condition; in fact, the general conditions around this plant are considerably above the average. At times the boilers *A* will begin to shake, the motion being with the line of flues and never crosswise of the boilers and only on the three large boilers *A*.

This shaking is most frequent when the plant is operating at full capacity and seldom occurs when the load is light. For a long time we have thought that this shaking was caused by the Corliss engine operating at heavy load, but we have about come to the conclusion that the trouble is in the boilers themselves.

Any suggestions from *Power* readers who may have experienced the same difficulty, will be appreciated, and if this trouble is found and stopped, I shall be pleased to give the readers all the details.

Allison, Ala. E. D. HEWLETT.

Effects of Superheated Steam on Metals

It is well known that the progress of steam-power practice is, to some extent, retarded because of the general opinion that superheated steam cannot be utilized at temperatures of more than 750 deg. F., especially where pressures of 500 lb. gage and over are used. As we know, ordinary steels begin to alter rapidly in tensile strength at these temperatures.

Consequently, although we have a large number of plants operating at 400 lb. and over, there are few generating steam at temperatures exceeding 750 deg.

Considerable difference of opinion exists on this subject, and recent performances at a well-known Belgian utility plant seem to indicate that the prevailing ideas concerning the deterioration of steels at temperatures above 750 deg. are exaggerated.

At Langebrugge in Belgium there are three horizontal water-tube boilers working at a pressure of 710 lb. gage and 840 deg. F. superheated steam at the stop valve. The steam is supplied to a turbine of the two-cylinder type operating at 8,000 r.p.m. and exhausting at a back pressure of 285 lb. The first cylinder drop is from 710 to 500 lb., and the steam leaving the turbine at 285 lb. pressure and 600 deg. temperature is passed on to an ordinary condensing turbine.

The only difficulties encountered have been with water-gage glasses and slight leakage in the boiler drums owing to high-pressure effects on riveted construction. Some minor explosions occurred in the superheated tubes, being due, it was thought, to air pockets. Blowing steam through them at the start seems to have eliminated the trouble.

The performance figures show that exceedingly good economy is obtained by operating at these pressures and temperatures, the results comparing favorably with the best central-station practice.

The other side of the question is presented in the April 12 issue of *Power* by Bert Houghton and D. C. Weeks, showing, by means of photomicrographs, distinct evidence of disintegration of the crystalline structure of turbine blading and cast iron. Their theory is an interesting one and blames the high temperatures, which, they say, exist only locally in pockets, for the release of agents destructive to the cementing of the crystals contained in the metal. If their statement concerning high localized temperatures in certain parts of the apparatus is true, it seems that the ultimate temperature has been reached in the superheater and we may look for the breaking up of the steam.

The fact remains that Langebrugge has operated at temperatures in excess of those thought safe and the developments along this line will be watched with a great deal of interest. R. G. EDWARDS.

Port Arthur, Ont.

Accident Sense in the Power Plant

Anything on accidents or accident prevention attracts my attention, so that the article in the May 24 issue entitled "Accident Sense in the Power Plant," by Thomas W. Gray, was read with some interest. I missed F. P. Terry's article on the same subject in the April 26 issue.

I disagree with Mr. Gray in that the accidents he cited cannot be prevented by any amount of precaution. All of them can be with a little foresight, and the power-plant engineer ought to think it worth while to take precautions in his own plant that are necessary from his own experience and from what he can secure from accidents that he has had. There are plenty of safety engineers who know absolutely what should be done in any kind of a situation, and there are a number of organizations that can assist the power-plant engineer in making his plant a safe place to work and, incidentally, a good place to work.

In the first instance the crank of the 20x42-in. slow-speed engine, referred to by Mr. Gray, could have been inclosed. The modern engine is inclosed for safety and to conserve oil, but the slow speed of operation should not be an excuse for permitting a dangerous reciprocating part to have no guards at all. A rail guard of standard construction would have saved the engineer and would also prevent anyone, familiar or unfamiliar with the premises, from being struck by the crank no matter how he was working around the engine, and there are several good ways of teaching engineers who dislike or refuse to do their work safely.

In the case where the engineer was fatally scalded because water was left in the boiler, why couldn't the engineer personally have investigated to see that the boiler was entirely drained? A little of the old army practice in making certain yourself that the job has been done irrespective as to whether or not orders have been issued, would have saved that man's life. Again it is foresight that prevents the accident, and this can apply to many different repair jobs around boiler and engine rooms.

As to the fireman who had a full night's job because a gage glass burst, this was a regrettable incident, but could have been prevented by different types of valves on the water column. There are shutoff valves available which can be operated by chains from the floor of the boiler room and certainly are the only things I know of which will enable steam to be shut off when a gage glass breaks. I personally think that automatic shutoff valves on water columns are dangerous. I believe a good many companies have used a general operated shutoff valve, and an illustration of this equipment is found on page 20 of the National Safety Council Safe Practices Pamphlet, number 49, entitled "Equipment and Operation of Steam Boilers."

Power-plant accidents are decreasing, and the decrease is due to the use and installation of safety devices. Most power plants could reduce the number of accidents through mechanical protection, and since mechanical protection has proved to be so efficient, isn't it worth while for every engineer to check over his plant before the accident happens and get the equipment that he would gladly pay ten times its value for in an emergency? It takes less time to prevent an accident than to report it. J. M. SANDEL, Director,

Bureau of Industrial Standards.

Harrisburg, Pa.

An Engineering Job Partly Done

The individual engineer is prone to narrow the field of vision to a careful scrutiny of one particular phase of a problem and is thus likely to lose sight of the problem as a whole. It is seldom, however, that this occurs with the engineers of an entire industry, particularly one as progressive as our central stations have proved themselves to be. The editorial in the issue of May 3 and the comments by Mr. Wagner in the issue of June 7 under the title of "How About the Power Losses Outside the Plant?" both emphasize such a point. The engineers engaged in the various phases of power generation and equipment design have devoted a large amount of technical study and research to the reduction in generating costs and to improvements in thermal efficiency of power generating equipment. The results attained are truly remarkable and speak for themselves.

Distribution cost problems are not confined to the sale of electrical power. Many other industries have similar problems. For years the close study maintained on manufacturing processes and costs, which has been practiced generally in industry, has resulted in obtaining reductions or holding stationary the production costs in spite of rising fuel, labor and supply costs.

The cost of distribution, sales and management, however, does not show this tendency, and with a decreasing production cost the relation of the various components of the cost have altered materially. While the manufacturing cost will no doubt be still further reduced as additional savings are effected, they will have a constantly decreasing effect upon all but the very large high-load-factor customer. The relative costs are such at the present time that the cost of generation could be omitted entirely without a material reduction in the sales price to the average purchaser of electricity.

The problem of low-cost generation has been solved by the engineers. The sales and management costs are executive problems and must be solved from that angle. The distribution problem is an engineering problem and no doubt will be solved as soon as the industry appreciates its necessity.

Improvement in efficiency and growth in size of the central-station generating equipment was accompanied by a decided trend toward the abandonment of the isolated industrial power plant in favor of purchased central-station power. So long as the isolated plants were of the older types, with comparatively low thermal efficiency, the substitution of central-station power resulted in both thermal and financial savings. In some exceptional cases combustible industrial waste, waste heat in furnace gases, or a large percentage of process steam rendered purchased power inadvisable. Such cases usually allow the generation of byproduct power at low cost.

Rapid improvement in thermal efficiency of the generating equipment, which accompanied this expansion in the public-service companies, has served to develop equipment suitable for the isolated plant for power generation which compares favorably with that in the central station. Thus many of the improvements that have been depended upon for reducing the cost of central-station power are now available for the isolated plant. Today, in the medium sizes, high-pressure steam-turbine units will generate power at surprisingly high thermal efficiency. In the smaller sizes the various oil engines offer a wide selection of low-operating-cost generating equipment.

It would thus appear that the central stations are faced with the problem of reducing the cost of delivering the power to the customer if they would prevent the back swing of the pendulum and prevent a recurrence toward the isolated plant for many industries. Some plants can never justify this change on cost alone, but there are many where the margin is small and the modern generating plant offers a more attractive proposition than could be obtained even a few years back.

The improvement in thermal efficiency of the central station does not show up so well when the figures are corrected to power delivered to the customer's meter. If the effect of the various losses from the power plant bus to the customer's feeder are analyzed for power furnished from a large system, some interesting figures are obtained, which will be somewhat as follows:

	Per Cent
Average thermal efficiency from fuel to busbars	20.0
Step-up transformer loss, 5 per cent, balance to high-tension line	19.0
High-tension line loss, 10 per cent, balance to step-down transformer	17.1
Step-down transformer loss, 5 per cent, balance to primary distribution	16.2
Primary network line loss, 5 per cent, balance to distribution transformer	15.4
Distribution transformer loss, 5 per cent, balance to customer	14.6

It would thus appear that the isolated plant would only have to attain an efficiency of 15 per cent to equal that of the large central station for the power delivered on the user's premises. There is a further loss in the customer's lines and equipment which has not been discussed.

The same degree of intensive engineering study devoted to this problem as has been expended upon the generation of power will undoubtedly result in a material reduction in this item. It is probable that a more liberal allowance for the size of conductor will be advisable when all the factors are considered. At the present time the power loss is evaluated against the investment cost of the copper. The additional cost of larger conductor will in many cases not seriously increase the cost of the line while being constructed but will be rather expensive to install as a replacement. Once installed, the tendency is to carry all the load they will handle and maintain voltage by boosting with voltage regulators. Much the same conditions exist in the feeders of the average industrial plant. The feeders are figured just sufficiently large for the original load, and as the load grows the losses become quite large in many instances, with the evils attendant upon low voltage.

Obsolete types of equipment and inappropriately selected apparatus are responsible for some losses. These may be rectified by substitution of newer types more particularly adapted for the service. Transformers are the principal equipment of this type operated by the power companies which will affect the losses. Some of the older types are very high in their iron losses.

A rather large and usually unsuspected loss lies in the gradual increase in leakage from the deterioration of the insulation throughout the system. This loss may be difficult to locate without an insulation test. It is possible to have the leakage balanced on the phases in such a manner that it cannot readily be noted with ground lamps. Insulation tests at frequent intervals are the only sure remedy. The elimination of leakage through faulty insulation not only will stop the waste of power, but will also prevent the final failure of the apparatus at inopportune times. Thus the various portable insulation testing devices are quite essential in the proper operation of electrical power equipment.

Dayton, Ohio. T. H. ARNOLD.

They Started Together as Oilers

The article in the June 7 issue by H. M. Friend, entitled, "They Started Together as Oilers," describes a condition that is more or less prevalent in power-house work. In fact, it is a condition common to all walks of life; that is, where some go ahead and others stand still or even retreat.

No one questions the assertion that it is easy to get into a rut. It is not easy to keep interested in all kinds of jobs. The monotony of some kinds of work makes it fairly impossible for the average man to become interested in it, notwithstanding the "go getter" articles of some of our popular magazines. The temptation to let up is a hard one to overcome for the plant employee who is working on a shift. The nature of his work is quite likely to destroy his ambition unless he is an exceptional individual. After one has spent a week on the graveyard shift, one's correspondence school studies are quite likely to be neglected, until one has caught up on some of the missed sleep. Of course the exceptional fellow will plug along with his studies regardless of unfavorable circumstances. Power houses are not likely to be filled with exceptional fellows; they are as a rule in lines of endeavor where the rewards for application are greater.

The young man starting in on the power-plant game, if he is ambitious, is looking ahead to the job that is just above him. If he is fortunate enough to be in a small organization, he may get advancement in a comparatively short time; with the larger corporation promotion may be slower. His is the case of the little frog in the big puddle, with the larger and more involved business unit. If his climb is slower than he had hoped for, he is likely to grow discouraged and give up trying. Then it is that he gets into a rut and becomes the average employee with little thought for the future. Because he has ceased to take an interest in his work, he is rather likely to miss any chances that come his way leading to the better job.

Many of the duties around a power plant are routine. It is the same thing month after month. If variety is the spice of life, then routine is its antithesis. The exceptional man will climb out of the monotonous job if given the opportunity; the average run of humanity will not. A great number of employees prefer a job that requires a minimum of effort; they do not desire to become foremen or superintendents. They are satisfied to let the other fellow do the planning and consequently reap the greater rewards. So much for the fellow who views the job as a job and nothing else.

Then there is the fellow who reads the alluring ads of the many schools that teach by mail and who is influenced by them to take up a course of study. He subscribes to a course of study that he thinks will produce more dollars in his pay envelope, and launches out on his school work with great zeal. Being a tenacious chap, he drives himself through the course and finally receives his diploma. During this time his boss may or may not know that he is trying to make himself a more valuable cog in the industrial machine. If, after painstaking effort, the path to the better job opens up, well and good, for another fellow being has been started on the road that leads to success and, maybe, happiness. If, on the other hand, our student is lost in the general mass of workers and is unable to show his wares, then the result is likely to be tragic. More than likely he will be soured on industry in general and his own job in particular. He may even think that only personal influence counts in this workaday world, that no matter how well a fellow is prepared for his life's work, only pull will get him anywhere. If the worker is foolish enough to let himself get into this frame of mind, then he has become his own worst enemy.

Not all of us are fitted for executive positions, although we have been told that there is an abundance of room at the top. Sometimes a good workman is spoiled by the idea that he was cut out to be a leader. If we were all captains of industry, who would carry the hod? Our industrial organization would be like the army of some of the smaller republics, all officers. No, the world will always have to have followers as well as leaders, so why close our eyes to a condition that will always be with us? This is not said to destroy the ambitious outlook of any worker. It is meant to destroy an illusion that by being prepared we can all reach the top, for we cannot. It is not to be assumed that only those who have scaled the heights of achievement were competent to do so. Napoleon is credited with having said that each common soldier carried a marshal's baton in his knapsack. Nevertheless, there was only one Little Corsican. What I desire to emphasize is just this: By all means prepare yourself for the better job, but do not take it too hard if the better job does not come your way. The time spent in study is not wasted, even though it does not result in a bigger pay check. Study broadens our outlook on life, and surely this is worth something, even if it cannot be capitalized into a dividend-paying investment. Then the discipline of self-education is surely worth something that cannot be rated in dollars and cents. Anything that makes life more worth while is certainly of value.

As for the case of Fred Jones, mentioned in the article by Mr. Friend, he may exemplify either one of two types: First, he may be too indolent to get ahead; or, having counted the cost, decided that the remote chance of advancement is not worth the effort. I like to think that he does not belong to either of these groups, but is a representative of that great body of workmen who faithfully do the day's duties with little thought of at last becoming the boss. He may even be one of those who, recognizing their own limitations, are content to do their best in the humble positions that they occupy. His is not the competitive disposition. He can be happy though nothing more than a private in the ranks of industry. He belongs to that great mass of humanity that Lincoln said, "God must have loved because he made so many of them."

Business would not function long without the Fred Joneses. The contented, capable workman is the salt of the earth. There never can be too many of them.

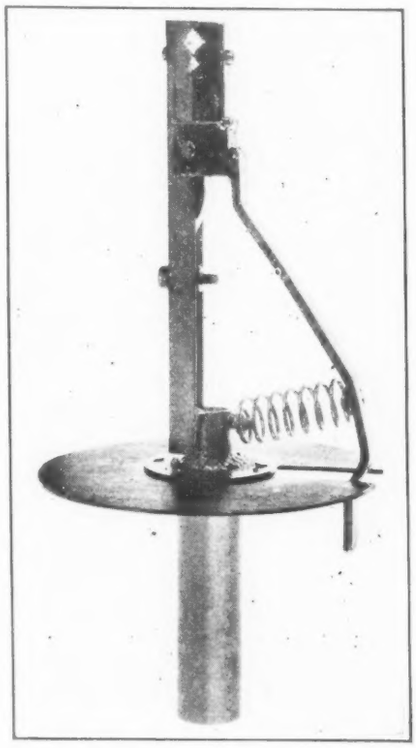
Finally, many of the Fred Joneses are church members. They have a week-day religion as well as one for Sunday. Some of them think deeply and intelligently on the philosophy of life. Striving for position and power is one of the things that the older members of this great class have decided is not worth while. I think of one in particular. His sons all hold positions in the engineering world that pay five-figure salaries; as for himself he is content to be a humble workman. And so I contend that the Fred Joneses of this group look upon life as something more than a contest for dollars. They believe that, to quote Scripture, "Is not the life more than meat and the body than raiment"?

Binghamton, New York. C. W. REYNOLDS.

New and Improved Equipment

Lincoln Type TR Heavy-Current Electrode Holder

To meet the demands imposed upon arc-welding equipment and accessories by the introduction of heavy current welding, the Lincoln Electric Co., Cleveland, Ohio, has brought out the type TR, 600-ampere metal electrode



Type TR electrode holder

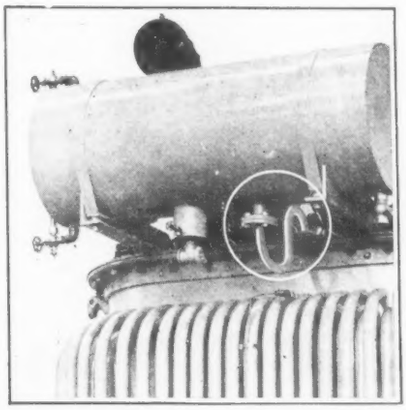
holder shown in the illustration, to handle metal electrodes in sizes up to ½-in. diameter.

The holder is fitted with replacable copper jaws, four-line contact for the electrode, all-copper path for welding current, and an insulated and ventilated handle and shield for protection of the operator's hand.

New Conservator Connector for Transformers

A U-tube has been adopted by the General Electric Co. as the connector between a transformer tank and conservator. The principal function of the conservator as applied to transformers is to prevent the absorption of oxygen by the hot transformer oil and thus prevent sludging. A conservator connected directly to the transformer tank through a small, straight pipe connection is effective in preventing the formation of sludge, but the prevention of thermal circulation by the U-tube keeps the oil in the conservator cool.

The new connector consists of a copper tube bent in the proper shape, with a steel flange brazed on each end for convenient connection to the conservator and the transformer cover, as shown within the circle in the figure.



Conservator connection shown in the circle

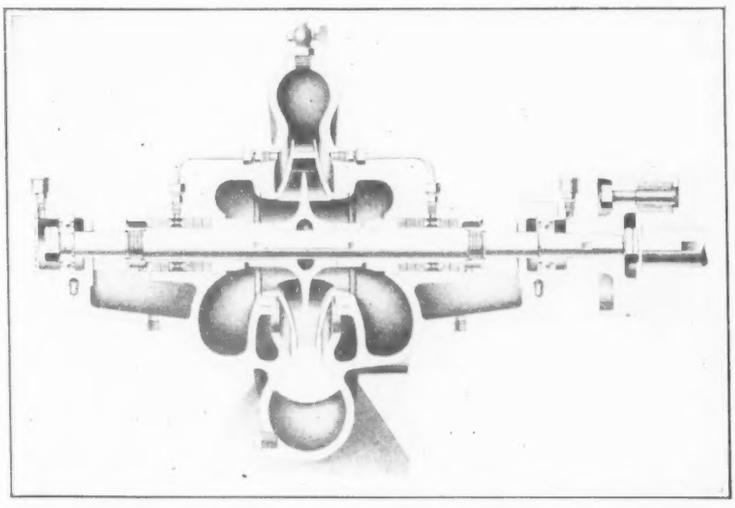
Advantages of the new connector are that it has only two flanged connections, whereas pipe and valve connectors require a larger number; it offers practically no resistance to the flow of oil in filtering; and, being flexible, it overcomes the difficulties experienced in the field when fitting the connections.

An improved shut-off valve for the conservator has also been adopted. Included in the advantages of the new valve are that it offers no resistance to the circulation of oil in filtering; it is provided with a "telltale" device on the operating handle to indicate open and closed positions; and it is welded directly to the conservator, and therefore requires only one flanged gasket joint instead of the two pipe joints required by other valves.

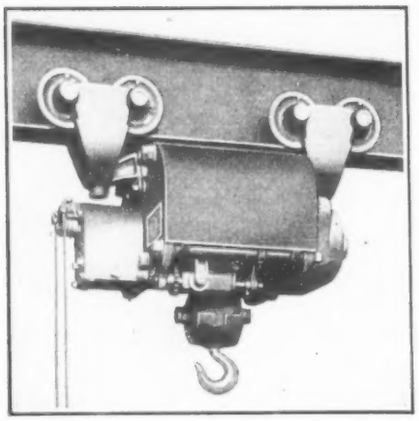
New Line of Worthington Centrifugal Pumps

High efficiency is one of the claims made for the new line of centrifugal general-service pumps recently brought out by the Worthington Pump & Machinery Corp., 115 Broadway, New York City. The new line is designed for standard motor speeds up to 3,600 r.p.m. and embraces three types as follows: A single-stage, single-suction type (types R and S); a two-stage, single-suction type (type U) and a single-stage, double-suction type (H, L and M). The design of the new pumps is claimed to be such that no pump will overload a standard motor of the horsepower and speed specified under any operating conditions to which the pump may be subjected in service.

The pumps are equipped with deep-groove ball bearings, the outboard bearing being so mounted as to take care of any unbalanced thrust in either direction. Each bearing operates in a one-piece hardened-steel housing held in place by a yoke. By removing the housing yokes, the shaft complete with bearings and bearing housings can be removed from the pump as a unit and replaced without disturbing the alignment. The bedplate is designed to take standard makes of motors and is provided with a raised lip, sloping top and drain.



Section of ball-bearing centrifugal general-service pump



Eight-wheel trolley hoist

American Lo-Hed Electric Hoist Monorail

To meet the need for a means of handling and conveying materials under minimum headroom conditions the American Engineering Co., of Philadelphia, has added to its line of Lo-Hed hoists a motor trolley electric monorail hoist that operates in 15½ in. headroom. It is built in ½- and 1-ton sizes and is similar in construction to the standard Class A Lo-Hed hoist, described in the Nov. 18, 1924, issue except that it is mounted on an 8-wheel trolley that reduces the headroom requirement by more than 5 inches.

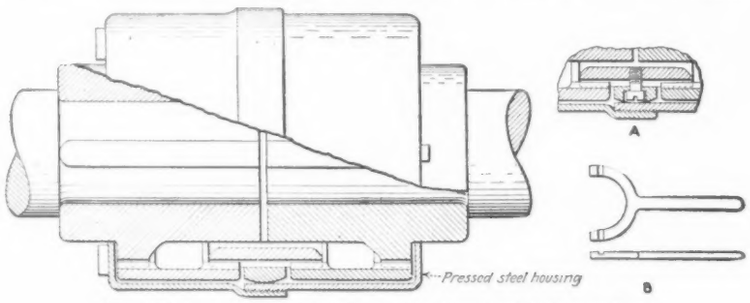
The hoist is made for operation with alternating-current at 20 ft. per min. or direct current at 20 to 40 ft. per min., and a special high-speed hoist provides for operation at 40 ft. per min. with a.c. and 40 to 80 ft. per min. with d.c. Standard height of lift is 20 ft., but when required, a lift of 25 ft. can be provided. The motors are fitted with ball bearings and are fully inclosed. Remote control of both hoist and trolley motors can be provided.

The hoist is designed to travel around curves of short radius and to shift easily over switches, roller bearings being used on the gear shafts and in the trolley wheels. The drive between the motor and drum is by means of spur gears running in oil. Grease lubrication is provided on all bearings not automatically lubricated by the oil bath. The unit is also equipped with lowering and holding brakes and a positive-acting upper limit device.

Dahlstrand Improved Flexible Coupling

A type of flexible coupling in which no bolts are used to transmit the load and in which exceptional lateral, angular and torsional flexibility are provided, has been brought out by J. Y. Dahlstrand, Wellsville, N. Y.

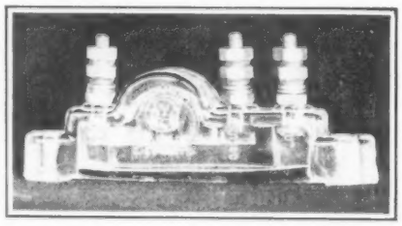
The coupling consists of two hubs keyed to the driving and the driven shaft, between which are interposed three sleeves equipped with claws to match similar claws in the two hubs. It is claimed by the manufacturer that the flexibility of the coupling is twofold and is not dependent in any way upon flexibility of materials; instead, it is dependent upon the compressibility of the oil films between the claws and on the mechanical arrangement of the various floating sleeves which permits them to rotate around axes different from those of the driving and driven shaft. The use of multiple sleeves tends to give equal distribution of pressures on all claws around the circumferences, thus greatly increasing the carrying capacity for a given diameter of coupling. The halves of the coupling are wholly inclosed in a pressed-steel casing having a screwed joint. The detail *A* shows how the central spacing ring is held in position and at *B* the spanner wrench for removing and replacing the pressed steel housing is shown.



Flexible coupling with three floating toothed members

New Autovalve Arrester for Low-Voltage Systems

To guard low-voltage systems against insulation breakdowns, including failures of relays, transformers and other apparatus resulting in interruption of service, a low-voltage autovalve lightning arrester has been introduced by the Westinghouse Electric & Manufacturing Co. which is fast in operation and capable of discharging high currents without failure.



Arrester assembled in glass case

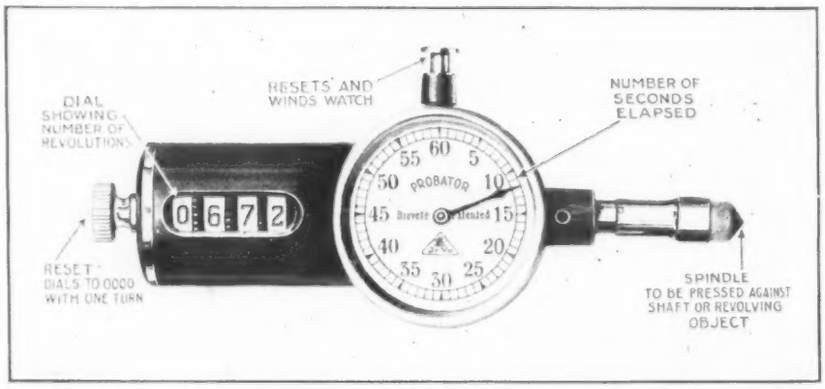
This arrester may be applied to alternating-current systems that operate at 65 volts or less and also to direct-current systems that operate at 45 volts or less. Some of the circuits to which it may be applied advantageously include all manner of signal circuits, fire-alarm systems and remote metering circuits.

Simplicity in design, speed of operation and ease of maintenance are other features of this arrester. It is encased with clear moisture-proof glass, making every part visible without removing the seal in the bottom. Maximum protection is provided by this arrester against high voltages due to a low discharge voltage and minimum delay in operation. Low resistance makes it possible for discharge currents of 1,000 amperes to flow through the arrester without causing a dangerous voltage across it.

Coxhead Combined Revolution Counter and Stop Watch

The illustration shows a combined revolution counter and stop watch (known as the Coxhead Probator) brought out by the Coxhead Corporation, Woolworth Bldg., New York City.

The revolutions are indicated directly on a dial reading up to 10,000, the dial being reset to 0000 with one turn of a knurled nut, as indicated. The stop watch records only when the spindle is pressed against the shaft or revolving object; thus the counter and watch automatically start simultaneously. The probator can be used separately as a stop watch by simply pressing on the end of the spindle sufficiently to set the watch in motion. The watch is wound and reset by pressing on the button shown at the top. The dial is graduated in ⅕ second.


DIAL SHOWING NUMBER OF REVOLUTIONS
RESETS AND WINDS WATCH
NUMBER OF SECONDS ELAPSED
0 6 7 2
55 60 5
50 PROBATOR 10
45 15
40 20
35 30 25
RESET DIALS TO 0000 WITH ONE TURN
SPINDLE TO BE PRESSED AGAINST SHAFT OR REVOLVING OBJECT

Combined revolution counter and stop watch

Today's Science and Tomorrow's Engineering*

By L. A. HAWKINS
Research Engineer, General Electric Company

WITH the work of Maxwell and Hertz in the '80's, which developed and demonstrated the electromagnetic theory, and showed that light, radiant heat and electricity are identical in nature, differing only in wave length, the physics of electricity seemed complete. It seemed probable that all the great discoveries had been made. The electrical industry had begun, basing its engineering on existing scientific knowledge, and on that original basis it has developed for the ensuing forty years. In the development of some of the devices now utilizing electric power, such as X-ray and radio tubes, new physical principles were involved, but the generation, transmission and distribution of electrical energy are still resting solely on the physics of Maxwell's day.

Does this mean that since then there have been no important advances in physical science? Quite the contrary. Physicists will agree that more important physical discoveries have been made in the past generation than in all the previous history of the human race. The most firmly established truths of thirty-two years ago have been overthrown or profoundly altered. Things which then definitely were accepted as forever unknowable have had their true nature revealed and have become the foundations of our new knowledge. And yet today it may fairly be said that we know more fully what electricity is than we know the true nature of anything else.

A generation ago science accepted the boundaries of our stellar universe in the direction of the infinitely great, and the boundaries of the atom in the direction of the infinitely small, as permanent limits to human knowledge. Today astronomers know that our universe with all its millions of stars is only one of myriad similar universes separated from us and from each other by inconceivable distances measurable only in millions of light years, while physicists know that the atom is a miniature planetary system composed of electrons moving at enormous velocities in tiny orbits around a central positive nucleus.

Thirty-two years ago, among the basic principles of science were the conservation of matter and energy, the immutability of the elements, the wave theory of radiant energy, the indivisibility of the atom, and the universality of the Newtonian dynamics. All these principles have been greatly modified or definitely overthrown. Matter and energy are not separate entities. On the contrary, what we call matter may radiate itself away in the form of energy, and probably, in the last analysis matter and energy are one. Certain of the phenomena of radiation, such as the photo-electric effect, are inconsistent with the wave theory, which no longer is accepted as telling the whole story of radiant energy. The atoms are not indivisible, nor the elements immutable. The radioactive elements are spontaneously disrupting their atoms and changing into other elements. The Newtonian dynamics fail when dealing with velocities approaching that of light or with microscopic quantities of energy such as the angular momentum of an electron.

THE history of progress shows that when scientific discovery has opened up a broad new field of knowledge, subsequent development of that field has nearly always produced great changes in the industrial, economic or social life of man. It seems inevitable that the enormous extension in our knowledge of physics, the most fundamental of all sciences, and the complete metamorphosis of all our basic physical conceptions, will lead to profound changes in the art which is based most directly on that knowledge and those conceptions—the art of electrical engineering.

The first practical result of the discovery of the electron, and of the insight it gave us into the nature of electricity, was the electron tube with high vacuum. The first tubes, like the first electromagnets, were small, low power devices. Just as the electromagnet found its first application in the communication field, creating the great new arts of telegraphy and telephony, before, after years of growth, it entered the power field in the form of generator and motor, so, too, the electron tube began its career in communications, first pointing the way to transcontinental telephony and then producing radio broadcasting.

Already the electron tube is creeping into the power field, for communications and control. Carrier current telephony, remote control of substations and of street lights, voltage regulation, synchronizing, telemetering, feeder protection, are some of the functions that tubes are now performing or are about to perform on transmission systems. Already the electric light and power company engineer must familiarize himself with the electron tube.

And the tubes are steadily growing in size and capacity. They give promise not merely of controlling, but of transmitting power in bulk. High-voltage tubes have been built to operate successfully on 500,000 volts. High-current tubes have passed as high as 600 amperes. Were it possible to combine both capacities in one tube, we would have a rating of 300,000 kva.

When such a stage is reached, the logical function of the electron tube in power transmission would seem to be as transformer from alternating current to direct current and back again. At the generating station and still more at the receiving and distributing end of a high-voltage system, alternating current has all the advantages because of the ease of its voltage transformation, but on the line, whether overhead or underground, direct current has all the advantages. When electron power tubes have become available in ratings of several thousand kilovolt-amperes, is it not logical to expect to find them at both ends of superpower lines, converting the generated alternating current to transmitted direct current and the transmitted direct current to distributed alternating current?

Until recently the electron, discovered nearly thirty years ago, has been taught to do its tricks wholly within walls of glass or metal, but with the development of the high-power cathode-ray tube we now have huge armies of high-velocity electrons turned loose in the air or in anything else we wish to shoot them into. One tube has an electron output equal to that of two or three tons of radium.

For many years, in fact ever since the chemist erased the line between organic and inorganic compounds, the possibility of synthetic food has been visualized. Under the pressure of the blockade during the War, German chemists were driven to attempt in earnest the synthesis of food-stuffs, with quite promising results. Since then, however, the discovery of the important functions of the so-called vitamins made such developments seem unattractive. Vitamins are mysterious elements in food which have never been isolated, but are essential to health and to important bodily functions. They seem to be for food what the so-called soul is in man, and just as it seems impossible to produce a mechanical automaton capable of all the functions of

*From an address before the Engineering Section session of the National Electric Light Association Convention, at Atlantic City.

an intelligent human being, so it seemed impossible to produce artificially a diet that would serve to replace the vitamin-bearing natural foods.

But recently it has been found that certain vitamins at least may be produced artificially. Food lacking in the vitamin necessary for the prevention of rickets may be made anti-rachitic by raying with either ultra-violet or cathode rays. What is true of this one vitamin may prove true of the others, and then the full nutritional value of natural foods should not only be equaled but surpassed by the products of chemistry.

Power today is supplied at high efficiency and heat at an electrical efficiency of 100 per cent, but the efficiency at which light is supplied remains a reproach and a challenge to science. Our best lamps have an efficiency of only about 4 per cent in terms of the ideal light or of about 8 per cent in terms of luminous radiation. Surely, such an economic waste cannot long endure. And our knowledge of light production is fast growing. We may not be sure, as we once were, that light is a wave motion in the ether. We have no exact conception of the mechanism by which a ray of light is originated, but we do know that it is somehow produced when an electron hops from one orbit to another in its atom, and we know with reasonable certainty what kind of hop produces what kind of ray. The problem, then, of producing a lamp of ten or twenty times the light efficiency of the present Mazda lamp is to learn how to direct our electric energy so as to make it all effective in causing the right kind of electrons to make the right kind of hop.

Impurities in Feed Water and Their Effect on Boiler Operation*

By J. B. ROMER†

DEMANDS set forth by the users of boilers cover a wide range, but in the present paper will be limited to those arising from the impurities in feed water. The principal troubles attributed to these impurities are scale, corrosion, embrittlement, priming and foaming.

Scale in boilers is responsible for lowered efficiency and blistered and ruptured tubes.

Corrosion results in a thinning of the metal that may cause its early failure or it may result in the lowering of the safe working pressure, thereby impairing the usefulness of the boiler.

Embrittlement manifests itself by a cracking of highly stressed plate. Its relation to water impurities is subject to argument.

Priming or foaming causes wet steam, or in extreme cases slugs of water, to pass over to the engine, with the attendant dangers.

The cause of these conditions lies in the nature and extent of the materials found in water.

Minerals in Boiler Water

In most waters the mineral matter present consists of a few bases and acids so combined as to give a number of different compounds. The bases usually encountered are the alkaline earths, calcium and magnesium; the alkalies, sodium and potassium, which for convenience will be referred to as sodium, and usually a small amount of iron. The acid radicals that are present are bicarbonates, occasionally carbonates, sulphates, chlorides and nitrates.

Calcium bicarbonate and calcium sulphate are encountered in almost all feed waters. Calcium chloride occasionally, and calcium nitrate is rarely found. Of the magnesium compounds magnesium bicarbonate is about as universal a constituent of water as is calcium bicarbonate. The sulphate, although present in many waters, is absent in many cases where calcium sulphate is present. On the other hand, magnesium chloride is a much more common constituent than is calcium chloride.

In certain well-defined geological districts sodium bicarbonate is a common constituent. Such waters, however, represent only a small portion of the total supply. Sodium sulphate and sodium chloride are found in practically every instance, and in very small quantities sodium nitrate is a common constituent.

In addition to these minerals there are always small amounts of iron, silica and organic matter present.

Effects of Various Minerals on Boiler Operation

Calcium and magnesium bicarbonate represent a somewhat unstable condition. They are, in reality, calcium and magnesium carbonate held in solution by the presence of CO_2. Therefore, any condition that will remove the CO_2 will immediately result in the precipitation of the calcium and magnesium carbonates. Fortunately, boiling water at atmospheric pressure will not hold gases in solution. Therefore, if water is heated to the boiling point, held there long enough for the gases to escape, a rather complete removal of the calcium and magnesium bicarbonates can be expected. If, on the other hand, the water is pumped directly to the boiler without sufficient preheating, then the expectation will be that the carbonate will precipitate within the boiler. However, this usually takes place in the cooler parts and the resultant sludge settles out in the mud drum, where it can be blown out readily as a soft sludge, but if care is not taken to prevent this calcium or magnesium carbonate from settling out on the heating surfaces, a troublesome scale will soon build up.

Calcium sulphate has a decreasing solubility with increase in temperature; this results in its precipitation at the hottest points, which, in the case of a water-tube boiler, are those tubes nearest to the fire. The material also readily adheres to the steel tubes and acts as an excellent insulator, preventing the heat being transferred from the steel to the water. The result is a rapid heating of the metal to a point well in excess of the water temperature, frequently reaching such a temperature that the steel loses its strength, bulges, forms a so-called blister, and eventually ruptures. When the tube swells, it cracks the layer of calcium sulphate, permitting the water to reach the hot tubes, forming in the case of a blister a steam pocket underneath the scale, or if the tube has ruptured, there is a sudden flow through the opening.

In both cases the effect is the same; namely, all signs of scale are removed from the immediate neighborhood, and this leads many engineers and boiler operators, believing that the trouble is due to defects in the steel and not to the presence of scale, to point with considerable emphasis to the fact that in the immediate locality of the blister or rupture there is no scale present. Investigation shows that the steel is entirely satisfactory and indicates the presence of scale in other parts of the boiler.

In many cases when calcium sulphate is precipitated, it mechanically entraps a good deal of calcium carbonate, silica, suspended matter, etc., which has not settled out to the mud drum; the result is a combination of sulphate and carbonate scale, the effect of which is the same as already described.

Magnesium sulphate is quite soluble and is not a scale-forming constituent; on the other hand, it has corrosive tendencies which result in the formation of pits and serious damage to the steel parts.

Magnesium chloride is extremely troublesome. The generally accepted theory is that it goes through a cycle, the net result of which is that a little bit can do a lot of harm. Whenever magnesium chloride is introduced into a boiler and no steps are taken to offset its action, corrosion results. Typical

*Abstract of paper read before American Water Works Association, Chicago, June 8, 1927.

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pits are quickly formed, and these eventually become deep enough to penetrate the metal and necessitate replacement of the part in question.

Sodium bicarbonate is neither scale forming nor corrosive in the usually accepted meaning of those terms. However, owing to its eventual hydrolosis to sodium hydrate, it can be classified as a harmful element.

Sodium sulphate and sodium chloride are present in practically all waters; they are rarely considered corrosive and are not scale forming unless the concentration is excessive. In the presence of oil, soap or suspended matter, sodium salts are troublesome from the viewpoint of priming and foaming. Iron, although present in almost every water, is of no moment so far as boiler feed waters are concerned, unless it happens to be present in the form of ferrous sulphate, under which condition the problem is really that of sulphuric-acid corrosion.

Invariably, a small amount of silica is present in all waters; as a rule it is of no moment. However, there are many cases where it becomes a serious problem, especially as it frequently forms a calcium-magnesium silicate that tends to produce a very troublesome scale.

In many parts of the country where muddy waters are common, there is the burden of suspended matter. This may settle out and give little or no trouble, or it may come down as a hard scale, and in some cases it finds its way to the surface of the water, where it becomes extremely troublesome as a priming and foaming agent. The nature of this suspended matter varies materially; it may be a fine colloidal clay, in which case it is most difficult to remove. On the other hand, it may be more of a suspension and therefore it can be removed by filtration.

The foregoing covers briefly all the minerals usually found in natural waters. In the coal-mining districts the operator is confronted with the problem of acid waters due to the oxidation of pyrites into ferrous sulphate. This, as previously stated, is in reality a sulphuric acid problem, the result in both cases being extensive corrosion. In many cases it is necessary to deal with such as trade wastes, which may contain almost anything in the nature of acids, alkalies, oils, organic matter, etc.

It can be seen that almost every salt that is present in water is troublesome in one way or another. Calcium salts are the chief scale-forming constituents. Magnesium salts are the chief corrosive agents. Sodium salts, although in some cases quite harmless, have an embrittling action and at the same time they can be considered as one of the principal causes of priming and foaming, being aided in this latter characteristic by the presence of oils, scaps, sewage and suspended matter. This might lead one to say, why not use pure water at all times?

Corrosion

When surface condensers first came on the market, it was felt that with a feed water at least 95 per cent distilled, boiler troubles were virtually over, especially as certain plants decided to evaporate the makeup, thereby having the feed water 100 per cent distilled. This brought about a new set of complications; it was soon realized that very pure water was corrosive from two viewpoints—the presence of dissolved oxygen and the presence of hydrogen ions. The former is particularly troublesome in connection with feed lines, heaters and economizers; the latter is troublesome throughout the entire cycle of the boiler.

An ideal feed water is one that is neither scale forming nor corrosive, and will not cause embrittlement, priming or foaming. Unfortunately, such waters do not exist, and it therefore becomes necessary to treat the existing supplies so that they will conform to these requirements. This is accomplished by various treatments. In many cases the treating is done outside of the boiler and permits making a thorough job. In other cases efforts are made to treat within the boiler; the results are never as good, because no boiler is a chemical stew pot.

Corrosion, Its Causes and Prevention*

CORROSION in feed-water heaters, economizer tubes, boiler tubes, etc., is often a cause of considerable expense and might cause rapid failure. The destructiveness of certain waters is known, and various practices have been adopted to combat the ravages of rust. In spite of precautionary measures, it is noticed that corrosion in some cases is worse today than a few years ago. This is particularly true in locomotives. Many operators have concluded that modern pipes, tubes and other metal parts in a boiler plant are not as resistant as those made a few years ago. Such an attitude is unjust when it is considered that a number of factors have combined to make conditions more severe during the last few years.

The Theory of Corrosion

The electrochemical theory has been accepted as generally the one that best explains the facts of corrosion.

Iron has a definite, inherent tendency to go into solution when placed in contact with water. Water dissociates into hydrogen ions and hydroxide ions. As the iron goes into solution, it unites with the hydroxide ions of the water to form iron hydroxide, and results in the liberation of hydrogen which gathers on the surface of the iron in the form of a thin, invisible film.

This film protects the metal from further solution unless removed by some external force.

In water containing quantities of acid, the tendency for hydrogen to plate out is much greater than in pure water. Corrosion, therefore, is more rapid in acid solutions. In practically all boiler waters the amount of dissolved oxygen is the controlling factor.

Boiler corrosion is rarely uniform over the entire surface of the metal and pitting is the result. This is the most destructive form of corrosion. Dissimilar metals in contact, such as iron and copper, set up a galvanic action and pitting is the result. Impurities in the metal and strained portions of the metal will also increase the localization of corrosion.

Factors that are Becoming More Severe

Many factors affecting the rate or total amount of corrosion are becoming more severe. Among these is the chemical composition of the water. This is due to contamination by acid waste from galvanizing plants, coal mines, paper mills, dye works, etc. This acidity is also increased by the decomposition of organic matter in sewage.

Another factor tending toward severe corrosion is the higher rating of boilers. Since corrosion depends, among other things, upon the amount of water passing through the system, corrosion will be considerably more severe at the higher ratings.

Another tendency in modern boiler practice is to increase the pressures and temperatures. Since corrosion increases proportionately with temperature, this is another factor to make the conditions severe. Since it is impractical to stem the march of progress, endeavors must be limited to more complete water treatment and oxygen removal.

Boiler-Water Treatment

Corrosion is less severe in hard-water districts than in soft-water districts. Hard waters are endowed with the property of forming scales, many of which are protective. They prevent water from reaching the metal surface. However, the presence of scale in boilers is generally objectionable. They not only reduce the efficiency of the boiler, but the sulphate scales increase pitting underneath their surface. Therefore softening of hard waters for boiler use is almost universally practiced.

The basis of practically all the chemical softening compounds is soda ash or soda ash and lime. The Zeoloite method of softening water does not remove acids. The general practice is to soften the water by lime and soda ash before passing the water through the Zeolite apparatus.

Soft waters do not require the addition of lime or soda as a scale preventive. The common plan is to neutralize the acidity by caustic soda, and enough should be added to keep the water distinctly alkaline. The mere neutralization of acidity in a boiler water by no means entirely prevents corrosion. As long as dissolved oxygen is present in the water, corrosion will continue.

Waters carrying any considerable quantity of scale-forming salts are objectionable for steam generating purposes, but a small amount of hardness is often considered a virtue from a corrosion viewpoint. This is due to the property imparted to the water of forming a protective film in pipe lines and boiler tubes and thus considerably reducing corrosion and pitting. However, the changing times are bringing us to the use of evaporated water, and as a result no protective films are formed by the water and corrosion is often very severe. If pure evaporated water contains no dissolved oxygen, there will be no corrosion. Therefore deaëration is practiced in a great many modern power plants.

An open feed-water heater, operating at or near the boiling point of the water, will remove the dissolved oxygen to a residual amount of about 0.5 c.c. per liter. This small amount of oxygen probably will not cause much damage if the water contains a little hardness. If evaporated water is employed, the oxygen must be reduced to about 0.03 c.c. per liter to insure proper protection. This oxygen removal can be accomplished only by the use of specially constructed deaërators which operate under a partial vacuum.

During the construction and installation of new boilers more or less grease finds its way into the plates and tubes. This should be removed by adding 2½ lb. of soda ash per 1,000 gal. of water and boiling with a slow fire at atmospheric pressure for at least 48 hours. After the boilers are emptied, they should be thoroughly washed out with clean water applied by a hose at high pressure.

After the boilers have been thoroughly cleaned, about 10 lb. of lime for every 30,000 lb. water capacity should be mixed with the cold feed water and run into the boiler, and from 4 to 6 lb., of lime, as milk of lime, for every 30,000 lb. water capacity should be added each day for not longer than six days. Milk of lime is a mixture of about 1 lb. of unslaked lime or 1¼ lb. of hydrated lime, with 1 gal. of water. Lime additions are made, as a rule, only when the boilers are new or after retubing. The lime treatment should be completed before any other treatment is applied to the water. Lime is soluble to about 90 parts per million at 200 lb. boiler pressure (382 deg. F.), so that the excess over this amount will be deposited as a soft scale on the metal or as sludge.

The action of the water is concentrated on areas from which the mill scale has been removed, and if this is a small proportion of the whole surface, pitting may result. More uniform corrosion and longer life of the tubes may often be obtained by first pickling them free from scale and then washing them in warm water and in milk of lime before they are installed.

If as great strides are made in the next ten years as have been made in the last ten years, little trouble from corrosion should be experienced a decade hence.

*Abstract from a paper by C. R. Texter, presented at the June convention of the National Board of Boiler and Pressure Vessel Inspectors, Nashville, Tenn.

Injuries by Frost Bite Not Compensatable

By Leo T. Parker

IT IS important to observe that the Supreme Court of Illinois, in Consumers' Co. vs. Industrial Commission, et al., 154 N. E. 423, rendered a decision that is interpreted broadly to mean that workmen are not entitled to recover compensation for any injuries received in consequence of the hazards of the natural elements of the particular locality in which the injury resulted.

The facts of this case are that a workman, while shoveling coal, suffered injuries through frost bite. The Court held that the injury was not compensatable, and said:

"The question in dispute is whether the injuries suffered by defendant in error arose out of his employment. Injuries resulting from exposure to weather conditions, such as heat, cold, ice, snow, or lightning are . . . not within the purview of Workmen's Compensation Acts, although the injured person, at the time he received his injury, may have been performing duties incident to, and in the course of, his employment. The rule is generally recognized, however, that, if an employee, because of his duties, is exposed to a special or peculiar danger from the elements—a danger that is greater than that to which other persons in the community are subjected—and an unexpected injury is sustained by reason of the elements, the injury constitutes an accident arising out of and in the course of the employment within the meaning of the Workmen's Compensation Acts. If the character of the employment is such as to intensify the risks that arise from extraordinary natural causes, an accident under such circumstances is one arising out of the employment. The causative danger must be peculiar to the work, and not common to the neighborhood. It must be incidental to the character of the business, and not independent of the relation of master and servant. If the accident, under the circumstances of the employment, was merely a consequence of the severity of the elements, to which persons in the locality of the elements whether so employed or not were equally exposed, it is *not* compensatable. . . . Of the six men who shoveled coal in the same yard at the time, defendant was the only person who experienced the frostbite of his hands. That he chose to wear unlined leather gloves in doing his work is immaterial in the instant case, unless in the performance of his duty he was required to wear such gloves. There is no proof of any such requirement. The fact that the other workmen did not suffer the injury of which he complains, although they were engaged in the same work at the same time and place, shows that he was not, by reason of his occupation, exposed to a special or peculiar danger from freezing greater than that shared by other persons in the same locality. It follows that the accident did not arise out of the employment."

In the case of Beach vs. Keicher, et al., 289 S. W. 519, the Supreme Court of Tennessee rendered a decision holding that an injured employee relinquished his right to compensation for an injury, where he failed to give his employer the statutory 30 days written notice, notwithstanding the fact that the employer had full knowledge of the details of the injury.

The facts of the case are that a workman was seriously injured while engaged at his regular employment. He was taken to a hospital where he remained two weeks.

His counsel argued that the 30 days written notice was not necessary because the employer had actual notice of the injury and was not prejudiced by the failure to give notice.

In holding the workman *not* entitled to compensation, the court said:

"We were dealing with the question of what constituted reasonable excuse for failure to give notice, and did not intend to convey the impression that actual knowledge of the injury, in and of itself, was a sufficient excuse. . . . Taking the record as a whole we are impressed with the idea that the petitioner did not intend to make claim for damages until some months after the accident, and his failure to give notice was likely due to that fact. . . . It is not necessary to decide whether physical disability, if shown, could constitute a reasonable excuse for not giving notice."

In Galveston H. & S. A. Ry. Co. vs. Contois, 288 S. W. 154, the Court considered whether a helper who holds a piece of metal while another cuts it with a cold-chisel and hammer is entitled to damages for injuries received when a chip struck him in the eye as a result of a heavy blow of the hammer.

It was contended that the workman was negligent and assumed the risk attendent with the work.

However, the higher Court held the workman entitled to recover and said:

"He (workman) knew that chips would fly from the grating in being cut by hammer and chisel, and was charged with knowledge of the danger to which he was exposed by this method of cutting the grate, whether the company was or was not negligent in causing or permitting the grates to be cut in this manner. He therefore assumed the risk of injury caused alone by the method used in cutting the grate. . . . There is no evidence in the record indicating that he knew or had any reason to suspect that the carpenter would strike the chisel with a negligent degree of force, and the evidence supports the finding of the jury that this act of negligence on the part of the carpenter proximately contributed to cause his injury. This act being an efficient cause without which the injury would not have been sustained, he did not assume the risk of injury caused thereby. . . . Contois (workman) did not assume the risk of the injury caused by the negligent act of the carpenter by reason of placing himself in such position that the pieces of metal that might fly off as the grating was being cut might strike him in the eye. *Assumed risk and contributory negligence are separate and distinct defenses.*

The Effects of Water-Cooled Walls on Furnace Operation*

By W. J. WOHLENBERG† and F. W. BROOKS‡

THE mean temperature existing in a furnace and the temperature of the refractory wall surface exposed to radiation are factors that limit the rate of energy release. The permissible mean furnace temperature is determined by the fusion temperature of the fuel ash and the permissible refractory temperature by the fusion temperature of the refractory.

The mean furnace temperature is the result of: The rate of energy input; the rate of energy discharged to the furnace walls; the rate of energy absorption by the gases within the furnace.

The first quantity is determined by the rate of burning fuel, plus the energy brought in by the air supporting combustion. The second quantity is largely influenced by the character of the furnace walls; that is, the extent of the water wall and refractory surfaces of the furnace. The third quantity is determined by the thermal capacity of the resulting gaseous mixture.

In discussing the influence of water-cooled walls, the author has used the term "fraction-cold," representing the ratio of the projected water-wall area in the furnace to the total wall area in the furnace. He shows by curves that when this ratio is equal to 0.4, the least total boiler surface is required for a given final gas temperature. Other curves are presented which show how the fraction-cold influences the exit-gas temperature for a given convection surface and indicates that as the temperature is decreased the extent of the water-cooled surface causes but a small difference in the exit temperature.

A considerable extension of the water-wall area in the furnace over and above that representing the best fraction-cold does not result in a reduction of the total heating surface requirements for given conditions as to rate of energy release and combustion. On the contrary, it generally results in an increase of the total surface requirements for a given final escaping gas temperature.

When water-cooled furnace walls occupy a considerable part of the furnace, they serve to permit an increase in the rate of energy release for a given furnace temperature.

A set of graphs are presented which show for given conditions how the mean flame and refractory temperatures vary with the fraction-cold for different energy release rates and entering air temperatures. The data from these curves are replotted in another set of graphs, which are useful in showing how the permissible rate of energy release for a given limiting ash-fusion temperature may be increased if the fraction-cold is increased. It is noticed in all cases, if, for example, the fraction-cold is increased from 0.2 to unity, that the permissible rate of energy release for a given flame temperature may be more than doubled. This is the particular advantage gained by the use of water-cooled walls. The same effect can be obtained by increasing the percentage of excess air, but to a much less degree. The permissible increase in energy release for an increase from 20 to 40 per cent excess air is small compared with that which would result should the fraction cold be increased from, say, 0.2 to 0.4.

THE influence of the extent of water-wall surface on the heat-absorption efficiency of the boiler as a whole, on permissible rate of energy release, and on the permissible range of load variation, is presented in this abstract.

The furnace designer should proportion his furnace walls for desirable combustion conditions by including the proper amount of cold surface. A reasonable variation of excess air may then be looked up primarily as a controlling variable in the operation of the furnace, but not as a cure-all that the designer may eventually fall back on in operation to correct the mistakes of poor design at the outset.

Refractory Temperature

Graphs illustrating how furnace refractory temperatures vary with the fraction-cold and the rate of energy release, are also shown. These, together with the mean furnace temperature curves, form the kind of data most useful in determining furnace proportions and kinds of refractory materials to be used. These curves indicate, with respect to limitations imposed by refractory walls, that a higher rate of energy release is possible in the stoker-fired furnace at 40 per cent excess air than in the pulverized-coal furnace at 20 per cent excess air, when, for the condition considered, the fraction-cold is greater than 0.4. At high rates of energy release the mean refractory temperatures would be higher for pulverized-fuel furnaces than for stoker-operated furnaces. This is a condition to be considered in connection with any possible development toward considerably higher rates of energy release in the pulverized-fuel furnace in which uncooled refractory walls are to be used.

An example is presented to show how these curves may be applied to solve a given furnace problem. In the discussion of this example, and with the aid of additional curves, it is shown that at low rates of energy release the mean furnace temperature is lower for a furnace with high fraction-cold than with a furnace having all refractory walls. This condition obviously has an important bearing on the permissible low rates of energy release. To prevent excessive losses, due to incomplete combustion, the furnace should not be operated at low temperatures. The permissible range of load variation for a given permissible range of variation in mean flame temperature is decreased as the fraction-cold increases.

For large steam generating plants a high maximum capacity is often of greater importance than a wide permissible range of load variation. With a sufficient number of units installed, the load variation may be adjusted by cutting them in and out for small increments of load change, thus maintaining an economical rate of energy release on all units in service.

Refractory Coated Water Walls

The author closes his paper with similar curves showing the effect of covering the bare water walls with refractories of various thicknesses. The advantage of lining water-cooled walls with refractory is due to the increased mean furnace temperatures obtained at low rates of energy release. Little thermal advantage is obtained from refractory-covered water-cooled walls when the refractory thickness becomes greater than two inches.

Recent Application Made for Water Power Projects

The American River Water & Power Co., Auburn, Calif., has applied to the Federal Power Commission for a preliminary permit covering a proposed development on the North and Middle Forks of the American River in Placer County, Calif. The main reservoir, on Middle Fork, will have a capacity of 100,000 acre-feet. The water from the North Fork is to be diverted and stored in that reservoir. The water from the reservoir will be conducted through ten miles of canal to power house No. 1. The water is then carried another ten miles in canals and tunnels to power house No. 2. In this way 54,380 hp. of primary power can be made available. The installation will amount to 80,227 hp.

*Abstract from "Some Fundamental Considerations in the Design of Boiler Furnaces," presented at the Tri-State Power Meeting of the A.S.M.E.

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Recent Publications

Metal Statistics 1927. Published by American Metal Market, 11 Cliff St., New York City. Cloth, 4x6 in., 544 pages. Price, $2.

The Metal Statistics 1927 is the twentieth annual edition. It represents an effort to present a neat, compact and ready summary of the metal industry. The data are given in table form and data of preceding years are included as a basis of comparison. The treatment is unusually clear, with new and ingenious methods of presenting tabulated facts. The volume should be valuable to those connected with the metal industry.

Inventions and Patents. By Milton Wright. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1927. Cloth; 6x8¼ in.; 217 pages. Price, $2.50.

This book is a treatise on patent tactics. In a concise and highly illuminative text, the subject is discussed from all angles. The patent law is translated into plain language so that the business executive or the inventor will understand its limitations. The text is illustrated with practical patent situations that help the reader to understand the author's meaning thoroughly. A patent is shown to be nothing more than a license to prevent others from manufacturing the article patented. How to proceed to obtain a patent and to negotiate for royalties or sale of the patent is explained clearly. The book is exceptionally clear and well arranged, and should be read by executives who are responsible for the protection of their company's output, as well as by inventors who contemplate securing a patent. It should be read in order to avoid existing traps and pitfalls, and the preservation of the invention.

A Physico-Chemical Study of Scale Formation and Boiler Water Conditioning—Bulletin 24, Mining and Metallurgical Investigations, Carnegie Institute of Technology. By R. E. Hall, Physical Chemist, U. S. Bureau of Mines; G. W. Smith and H. A. Jackson, Chemical Engineers, Hagan Corporation, and J. A. Robb, H. H. Karch and E. A. Hertzell, Research Fellows, Carnegie Institute of Technology. Published by Carnegie Institute of Technology, Pittsburgh, Pa., 1927. Paper; 239 pages; 54 tables; 42 illustrations. Price, $2.

This book is a report of various investigations made of scale formation and boiler-water conditioning made by the authors under the auspices of the Carnegie Institute of Technology, U. S. Bureau of Mines, and Mining and Metallurgical Advisory Boards, in cooperation with the Hagan Corporation. Many of the individual papers included have been previously published by the technical press. These have excited wide interest among engineers concerned with boiler operation and represent what is probably the most comprehensive attack yet made on boiler-water problems from the viewpoint of physical chemistry. From the practical point of view these studies have borne fruit in a new technique of boiler-water conditioning to overcome scaling troubles.

The book has five sections as follows: Part I, Principles of boiler-water conditioning; Part II, The solubility of calcium sulphate, barium sulphate and calcium phosphate at boiler-water temperatures; Part III, Relation of hydroxyl ion to the inhibition of corrosion; Part IV, The non-condensable gases of the steam; Part V, The increment of soluble and insoluble solids in boiler waters.

Manual of Endurance of Metals Under Repeated Stress. By H. F. Moore, Research Professor of Engineering Materials, University of Illinois. Engineering Foundation Publication No. 13, 1927. Cloth, 5x7½ in.; 63 pages; illustrated. Price, $1.

This manual outlines briefly the meaning and laboratory method of determining the endurance limit of metals. Of interest to designers is a table in which are given the endurance limits for a large number of ferrous and non-ferrous metals together with their composition, heat treatment and tensile strength. It is pointed out that these data are obtained from tests of small specimens and that for large pieces of the same metal the endurance limit would be lower than shown in the table, and the use of a safety or "ignorance factor" is necessary. The relation of various other physical properties to endurance limit is shown, and the effect of high temperatures, corrosion, chemical composition, heat treatment and cold working is discussed. The last chapter deals with fatigue failures in service and outlines a method for detecting fatigue cracks before failure occurs. The author presents his subject in an easily readable, untheoretical form, and the book contains much of interest to machine designers.

Principles of Mercury-Arc Rectifiers and their Circuits. By David C. Prince and Francis B. Vogdes. Published by McGraw-Hill Book Co., Inc., 370 Seventh Avenue, New York City, 1927. Cloth; 6x9 in.; 233 pages; 155 illustrations; 13 tables. Price, $3.

What may be termed static rectifiers have been developed in a number of commercial forms and in this country are attracting more attention than ever before; therefore, this book has appeared at an opportune time. The treatment has been divided into two parts. Part I deals with kenotron rectifiers, tungar rectifiers, construction of mercury-arc rectifiers, theory of mercury-arc rectifiers, physical properties of mercury-arc rectifiers, and arc-back of mercury-arc rectifiers. This part of the book is practically free from mathematical treatment and can be comprehended by those with an elementary knowledge of electricity and magnetism. Power rectifier circuits are dealt with in Part II, and this is largely a mathematical treatment, which is considered best suited to American engineering practice and deals with fundamental wave shapes and problems in rectifier regulation. This part of the book is of such a nature as to be chiefly of interest to the technically trained engineer. No attempt has been made to describe all the different types of rectifiers, it being the object to give a clear explanation as far as possible of the action of the mercury-arc rectifiers. The other rectifiers that are discussed are considered because they illustrate certain phenomena occurring in the mercury-arc rectifier.

Business Cycles and Business Measurements—The result of an extended research carried on with the object of obtaining broader and more detailed measures of trade, production, and business activities in the United States. By Carl Snyder. The Macmillan Company, New York. Cloth; 6x9 in.; 326 pages. Price, $6.

The striking variations in the fluctuations of trade, from prosperity to crises and depression which we have come to call "business cycles," have had in the United States a greater intensity and therefore arouse deeper interest than in perhaps any other country; and many attempts have been made to determine definitely the extent and regularity of this movement. But it is only in recent years and largely following the great burst of interest aroused during the World War, that the material has been available to make such definite measures. In this book the author has sought to put together this wealth of new material and from it derive measures of business from month to month, one of which is a wide composite of a weighted average of fifty-six independently computed series. Others have been found in close agreement with this broad combination, and building upon these foundations and the relationships therein established, it has been possible to carry back several measures of trade through more than half a century. These measures seem to show that the crises associated with the business cycle reached their intensity in the latter part of the Nineteenth Century, and have since been of distinctly lessened severity. But the course of these fluctuations is of wide import, and it is of deep interest to the business man, especially, to know just what is the current position of industries and trade with reference to that persistent and never-ending growth which, as the author has been at pains to show, is one of the fundamentals of American business. These new measures of trade and productive activity are set forth graphically in a series of over forty full-page charts, and with these are given *in extenso* the tables of index numbers from which the graphs are derived—a feature that will be of interest to students of business conditions.

News in the Field of Power

Installs Waste Heat Boilers in Florida Cement Plant

Installation of power equipment consisting essentially of waste-heat boilers supplying turbines to develop 5,250 kva., with all plant units individually driven, is nearing completion in the $5,000,000 plant of the Florida Portland Cement Co.

The turbines are Allis-Chalmers reaction type and are rated at 1,250 and 4,000 kva. respectively at 80 per cent power factor. They will feed through a 14-panel switchboard on the turbine floor of the power house.

The mill machinery will be driven by 134 induction motors from 1 to 250 hp., seven 550-hp. synchronous motors for the plant's seven grinding mills, and one 218-hp. synchronous motor for a 150-kw. direct-connected generator, which in turn is used to operate a 125-hp. car-dump motor. All auxiliaries of the power house up to 30 hp. and all auxiliaries in the mill up to 5 hp. are remote controlled by cross-the-line starters.

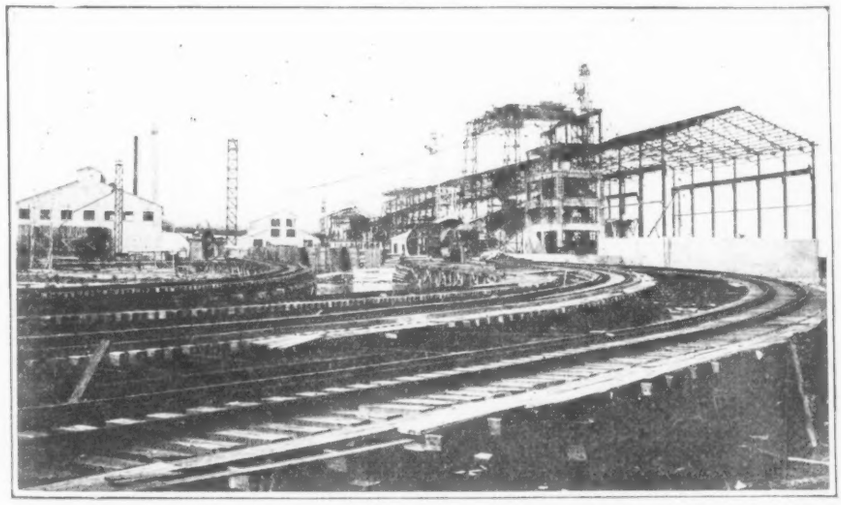
Some Equipment Used

Steam is supplied by three 9,000-sq.ft. Edge Moor boilers utilizing waste heat from the three kilns, which is pulled through each boiler by a 150-hp. motor-driven fan.

The kiln housing is designed so that all waste gases may be passed into the 217-ft. stack or used by any one or all three waste heat boilers. The boilers themselves are four-pass units with economizers beneath the fourth pass and superheaters between the first and second passes. They are designed for a working pressure of 225 lb. and 150 deg. superheat. Steam flow, draft, steam and water temperatures and pressure are indicated and recorded by suitable instruments.

In order to take care of fluctuations in power consumption, the power house is equipped with a Griscom-Russell evaporating system, which may be fed more steam for storing distilled water in the 40,000-gal. surge tank in periods when the load is low.

The plant, which has been under construction for more than a year, is situated on the water front of Hooker's point in Tampa and has a dock and bulkhead 1,300 ft. long supported by more than 20,000 piles driven from 15 to 35 ft. to bedrock. The several units cover an area of about four city blocks. It will have a capacity of 5,000 bbl. of portland cement a day and will consume about 125,000 tons of coal yearly.



General view of the plant of the Florida Portland Cement Co. at Tampa, showing power house at left

Planning Merger of Fifteen Midwest Power Concerns

Consolidation of 15 Wisconsin and northern Michigan public utilities in the Wisconsin-Michigan Power Co., all subsidiaries of the North American Co., was announced June 24 by S. B. Way, president of the company. The consolidated property represents a $16,000,000 valuation.

The Wisconsin Traction, Light & Power Co., Appleton, will join the consolidation, in which the former Peninsula Power Co., recently named the Wisconsin-Michigan Power Co., and 13 smaller companies will be merged.

Other Wisconsin companies included in the merger are: Wisconsin Northern Light, Heat & Power Co., Weyauwega Electric Light Co., Badger Utility Co., Star Electric Co., Aurora Electric Light & Power Co. and Niagara Light & Power Co.

Michigan concerns are Iron Mountain Electric Light & Power Co., Dickinson County Public Service Co., Powers-Spalding Light Co. and Twin Falls Light Co.

Iowa, Illinois N.A.S.E. Men Meet in Joint Sessions

Four hundred delegates and exhibitors were registered at the joint session of the Iowa and Illinois branches of the National Association of Stationary Engineers meeting at Rock Island, Ill. June 22-24.

The Illinois group upset precedent and paid W. L. Rhoades, of Decatur, a fine tribute for his efficient management of the unit by re-election to the presidency. The action was unforeseen by the committee that prepared the past-president's badge before the election, immediately following which, he received the branch tribute from F. W. Raven, Chicago, secretary of the National Association. W. A. Pike succeeded Frank J. Park, Rock Island, plant engineer of the Textile Products Co. to the presidency of the Iowa branch.

Visits were made to the big Bettendorf car shops in Bettendorf, Iowa, the Riverside power plant in Davenport, the government arsenal power plant and shops and the Sears water-power plant. Secretary Raven presided at the annual banquet and Dr. B. J. Palmer was the principal speaker.

Fifty booths had been erected by manufacturers for the power show, where machinery, tools, and all appurtenances to the stationary engineer profession were on exhibit.

Principal speakers at the joint sessions were H. R. Williams, manager of the service department of the Garratt-Gallahan Co., Chicago, manufacturers of boiler preservatives, Royal H. Holbrook, Ames, Iowa State College, past-president of the national organization, H. A. Kleinman, Peoples Power Co., Moline, and John W. Drabelle, Cedar Rapids, Iowa.

The Iowa branch elected to the following offices of president, W. A. Pike; vice-president, L. T. Hazelwood; Secretary, C. A. Bland; treasurer, J. A. Coulson; conductor, H. O. Grimes; doorkeeper, R. C. Larson; state deputy, W. W. Winger.

The Illinois officers are W. L. Rhoades, president; Enid E. Winholt, vice-president; W. L. Hamilton, secretary-treasurer; H. E. Hintz, conductor, and L. M. Hadley, doorkeeper.

West Penn Output Rises

West Penn Electric Co., which controls the electric properties of the American Water Works & Electric Co., Inc., reports a net power output for May, 1927, of 139,064,669 kw.-hr., compared with 113,735,485 kw.-hr. in May, 1926, a gain of more than 22 per cent. For the first five months of 1927 power output totaled 747,966,960 kw.-hr, as against 603,710,541 kw.-hr. for the corresponding period of 1926, a gain of about 24 per cent.

N.A.S.E. Backs Coming West Coast Power Show

Progress of the power industry in the west will be made apparent at the Pacific Coast Power and Mechanical Exhibit in Los Angeles, August 22-27, according to reports from California N.A.S.E. Association No. 2, which is arranging the exhibit, in co-operation with the National Exhibitors' Association, as an adjunct to the 45th annual convention of the National Association of Stationary Engineers.

More than three-fourths of the 200 exhibition spaces in the Ambassador Auditorium, which is to be the scene of the western power show, had been reserved by June 1, the California association has announced. The exhibitors include virtually all the leading power machinery and equipment manufacturers of the west and many of those in the eastern and mid-western fields. This show will be the first of its kind on the Pacific Coast.

All of the Rocky Mountain and Pacific Coast states are aroused to the importance of power development, so the association leaders say the show and convention could not have been held in a more opportune time. Manufacturers have reported rapidly expanding sales of machinery and equipment designed to fill the needs of that section.

Gas and Oil Included

Hydro-electric, milling and mining machinery are likely to play a leading part in the exhibit, because of the peculiar needs of the west. The association, however, has been assured that there will also be notable displays of gas and oil burning plants which will endeavor to prove themselves worthy competitors of electrical power.

Coal burning equipment will receive special attention, as cheap water communications on the coast are extending the use of this fuel even in regions where there is abundant hydro-electric energy, natural gas and petroleum supplies.

Water pumps, both horizontal and deep well, valves and valve fittings, which are part of the fundamental equipment of the industrial west, will abound at the show. Rock crushing and cement mixing machinery will attest the highway development of that section of the nation. There will be at least one big display of machinery used in the process of water purification.

To Investigate Various Qualities of Coal

A careful consideration is being given at the Bureau of Mines to the resolution passed recently by the American Gas Association recommending that the Bureau give an enlarged service in the determination of quality of American coals. The coal analyses made by the Bureau have been limited to the conventional proximate or an occasional ultimate analysis.

The Bureau has had an increasing number of requests from numerous sources for an investigation of the different coals so as to show their gas-making quality, their coking characteristics and their usefulness for distillation processes or other special uses. Such a program has been followed in the British study of coal. It is regarded as a natural outgrowth of the more intensive interest in coal as a raw material, rather than a simple fuel.

Many of the requests reaching the Bureau of Mines for information regarding the characteristics of coal cannot be answered as its work is confined largely to the analyzing of the coals bought on government contract. There are many districts producing large quantities of coal of which but little is bought for government use.

Canada Steel and Power Show Plans Ambitious Program

Although the steel and power show, of Canada, to be held in the University of Toronto Arena, Aug. 31, Sept. 1 and 2, is still more than a month in the future nearly all of sixty-one manufacturers who have contracted for space announce their intention of showing their products in operation, satisfaction being expressed at the arrangements for power, steam, gas, compressed air and water.

Decision of the Canadian Section of the American Welding Society, and the Montreal & District Engineers' Association to sponsor the exposition, with the Toronto and Montreal Chapters of the American Society for Steel Treating; Canada, Toronto and Hamilton Councils of the Universal Craftsmen's Council of Engineers; Dominion Executive of the Engineers' Mutual Benefit Fund; and Toronto branch of the American Electro-platers' Society, appears to indicate that the show will be comprehensive and interesting to Dominion engineers.

Displays of equipment in operation will include machine and electrical tools, industrial furnaces, pulverized fuel equipment, electric arc and oxy-acetylene welding apparatus, recording instruments, tube cleaners, valves, and traps.

The technical session program arranged has been planned to embrace practically every phase of metal working, heat treating, and power generating, with the addition of speakers on materials handling, and abrasive and refractory materials.

Sees Attempt To Localize Wilson Dam Power

Among various interpretations that have found voice on the recent visit to Washington of a delegation from Muscle Shoals City, Ala., seeking to secure for that township a lease with the federal government for power from the Wilson dam, is the opinion that the establishment of a precedent is being attempted for localizing to the Muscle Shoals area the power output of the Wilson dam and for embarking the government in the business of operating power plants and so selling electricity to the public.

The application of the municipality, in which thirty-one votes were cast at a recent election and which had revenues totaling $6,000 in 1926, has the active support of national leaders of that school of political thought which subscribes to the theory that the government should become a business institution.

The delegation insisted upon the "priority rights extended to municipalities by the National Defense Act and by the water power act." In that statement, however, there was some departure from accuracy, as the National Defense Act provides no priority rights to municipalities, and the water power act is not applicable to such a lease as that proposed. No decisions were announced, but a committee from the delegation will remain in Washington while the matter is under discussion.

Obituary

Charles T. Drake, superintendent of construction of the Carbondale Machine Co., with headquarters in New York City, died suddenly, June 5 at his home, 8826 183rd St., Hollis, Long Island, N. Y. Mr. Drake, who was 43 years of age, entered the Carbondale Machine Co. in 1903 and had served that company in various capacities ever since. He was of a studious disposition and energetic in the performance of all duties entrusted to him. He was deeply interested in association work and for the past several years had been treasurer of the New York Section of The American Society of Refrigerating Engineers. He was held in the highest esteem by his associates, and his death is felt as a severe blow to his many friends in the refrigerating engineering profession. As a tribute to his memory, President Bennis and the Council of the New York Section of The American Society of Refrigerating Engineers canceled the proposed meeting of the Section for the month of June.

Personal Mention

A. B. Newell, mechanical engineer, has recently become associated with Ingersoll-Rand Co. at the company's Phillipsburg, N. J., plant.

R. F. Terrill has been transferred from general engineering department of the Lincoln Electric Co. at Cleveland to the Eastern service division with headquarters at New York City.

Arno C. Fieldner, superintendent of the Pittsburgh Experiment Station of the United States Bureau of Mines, has been appointed to the position of chief engineer. Mr. Fieldner assumed this post July 1.

R. G. Richards, member of the Detroit Section, American Welding Society, formerly with Titus Welding Co. and Lincoln Electric Co., is now a member of the engineering staff of Slaymaker Electric Welding Co.

A. O. Avery, operating superintendent for the Kearny works, rounded out June 23 twenty years of continuous service with the Western Electric Co. In 1918 he was made chief of operating personnel of the Hawthorne telephone works, and in December, 1923, he became assistant operating superintendent of the Illinois plant. In February, 1926, Mr. Avery was promoted to as-

sistant technical superintendent and transferred to the Kearny plant, to be appointed Sept. 20, last, to the position of operating superintendent.

H. C. Thayer has left the Brooklyn Edison Co. to become furnace engineer with the Bernitz Furnace Appliance Co. He will specialize in furnace water walls and particularly in the Thayer Carborundum method of wall construction.

Business Notes

The Grindle Fuel Equipment Co., Harvey, Ill., has announced that the Burdick-Pensinger Co., 3409 E. 18th St., Kansas City, No. is now representing it in the sale of complete pulverized coal systems.

Chicago Pneumatic Tool Co., 6 East 44th St., New York City, announces the removal of its St. Louis office, service department and warehouse July 1 from 813 Hempstead St. to 1931 Washington Ave., St. Louis, Mo.

The Dayton-Dowd Co., manufacturer of centrifugal pumps, announces the appointment of James E. Degan Co., 622 First St., Detroit, Mich., as district representative for Dayton-Dowd centrifugal pumps in the Detroit district.

The Joseph Dixon Crucible Co., Jersey City, N. J., is a century old this year. To mark an unusual career of industrial accomplishment and prominence, an attractively prepared booklet entitled "A Tale of Yesterday, Today and Tomorrow," written by Floyd W. Parsons, has been published by the company.

The Midwest Ice Co., 3920 West Harrison St., Chicago, Ill. announces the change in name from that of the Grawoig Ice Co., the ownership and management of the company remaining unchanged under the active conduct of Isadore Grawoig as president. The company has purchased the plants, properties and business of the Fair Artificial Ice Co. and the Garfield Artificial Ice Co.

The Lincoln Electric Co. announces the following changes and additions in the sales and service department. L. P. Henderson has been transferred to Chicago in charge of welder service. J. E. Durstine has been transferred from the experimental engineering department to welder service department at Cleveland. J. W. Shugars, of the time study department at Cleveland, and R. D. Layman, also of Cleveland, have been moved to Detroit. D. H. Carver has been transferred from the machine shop division at Cleveland to the Ohio service division with headquarters at Cincinnati.

Trade Catalogs

Long Pipe Lines with Oxwelded Joints—This publication put out by the Linde Air Products Company is made up of interesting picture illustrations of long oil and gas pipe lines installed with welded joints.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Society of Civil Engineers. George T. Seabury, secretary, 33 West 39th St., New York City. Annual convention at Denver, Col., July 13-15.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit. Wisconsin convention at Racine, July 19-22, secretary R. L. Scott, 410 Congress St., Eau Claire, Wis.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Elevators and Conveyors—The Link-Belt Co. in Book No. 575 describes with installation photographs elevators and conveyors of many types for many uses.

Coal Loaders and Conveyors — The Barber Greene Co., 444 Park Ave., Aurora, Ill., has published an interesting and well illustrated catalog describing coal car unloaders, conveyors and coal loaders designed for cutting handling costs. Various types of performance are depicted with these three "yardmen" at work.

Valves—Hopkinsons Ltd., patentees and manufacturers of safety boiler mountings and valves, Britannia Works, Huddersfield, England, have published in illustrated catalog form three new lists of products: "S.P.S." bronze valves for steam, water and air, No. 1990; "Hopkinson-Ferrante" valve, No. 1920, and steam isolating valve, No. 1910.

Rotary Positive Blowers—The Connersville Blower Co. is just issuing another bulletin telling something of Connersville blowers. This is Bulletin 10C, in which is contained a general description together with tables of capacities on the Types H and H-H blowers for capacities of 400 to 2,200 cu.ft. per min. and pressures up to 2½ lb. per square inch.

Blow-Off Valves — Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. features in catalog B-410C a large variety of blow-off valves. Among those carefully described and depicted are Type A seatless valve for pressures up to 250 lb.; Type B balanced seatless valve; Type C long stroke balanced seatless valve; double-tightening valves and tandem valves.

Burns Pulverized Lignite—The Combustion Engineering Corp., 200 Madison Ave., New York City, describes in this publication the New Braunfels station of the Comal Power Co., Texas. This installation is notable because it is one of the three first plants to burn pulverized lignite successfully in every-day operation. The boilers comprising the units now in operation are equipped with the Lopulco storage system for burning pulverized fuel. This pamphlet will be sent without obligation to those requesting it.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	June 20 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.77
Clearfield	Boston	1.65@ 1.85
Somerset	Boston	1.75@ 1.95
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	1.90@ 2.10
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky	Louisville	1.35@ 1.60
S. E. Ky	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.50@ 1.90
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.25@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.30@ 1.50

FUEL OIL

New York—June 30, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—June 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 4.87½c. per gal.

Pittsburgh — June 22, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Philadelphia—June 15, 27@30 deg., $2.20½@$2.26½ per bbl.; 13@19 deg., $1.75@$1.81 per bbl.

Cincinnati — June 27, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—June 25, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.00; 30@32 deg., $1.10.

Boston—June 27, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5.85c. per gal.

Dallas—June 25, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

New Plant Construction

Ark., Batesville — Arkansas Power & Light Co., Pine Bluff, plans extensions and improvements to power and light plant including transformer station, etc., also transmission lines. Estimated cost $750,000. Private plans. Work will be done by owners' forces.

Calif., Eldridge—State of California, is having plans prepared for the construction of a boiler house and pumping plant at Sonoma State Hospital. Estimated cost $30,000.

Calif., Los Angeles—W. E. Chadwick, Union League Bldg., Archt., is preparing preliminary plans for the construction of a 5 story hotel including two electric elevators, etc. on Highland Ave. Estimated cost $500,000. Owners' name withheld.

Calif., Los Angeles—Interests headed by A. S. O'Neil, Stimson Bldg., Contr., awarded contract for the construction of a 13 story hotel on South Spring St. Estimated cost $1,000,000. Steam heating system, elevators, etc. will be installed.

Calif., Los Angeles—Parkinson & Parkinson, Title Insurance Bldg., Archts., are receiving bids for the construction of a 13 story medical office building including steam heating system, elevators, etc. at Westlake Ave. and Wilshire Blvd. for W. Morrison, Pacific Mutual Bldg. Estimated cost $500,000.

Calif., Stockton—City plans extensions and improvements to water and power systems at Stockton State Hospital. Estimated cost $10,000.

Calif., Stockton—Union Ice & Cold Storage Co., 354 Pine St., San Francisco, plans the construction of an ice plant, here. Estimated cost $300,000.

Conn., Danbury—North Shore Properties Co., Pershing Bldg., will build an apartment building on Stone St. Estimated cost $800,000. A. J. Thomas, 2 West 46th St., New York, N. Y., is architect. Work will be done by separate contracts.

Conn., Waterbury—Waterbury Hospital, Robbins St., awarded contract for the construction of a 4 story hospital to Torrington Building Co., 182 Church St., Torrington. Estimated cost $625,000.

Ill., Carthage—J. W. Westfall, County Clk, will receive bids until July 7 for the construction of a pumping station and dam at head of Rocky Run.

Ill., Chicago—R. De Goyler & Co., 307 North Michigan Ave., Archts., will soon receive bids for the construction of a 13 story apartment at 7321 South Shore Drive for W. C. Bannerman & Co., 77 West Washington St. Estimated cost $1,000,000.

Ill., Chicago — De Paul Educational Society, 84 East Randolph St., is having plans prepared for the construction of a 16 story office and stores building at 64-68 East Lake St. Estimated cost $2,000,000. K. M. Vitzhum & Co., 307 North Michigan Ave., are architects.

Ill., Chicago—Lowenberg & Lowenberg, 111 West Monroe St., Assoc. Archts., are receiving bids for the construction of a 17 story apartment at 101-109 East Delaware Pl., for Delaware Building Corp. Estimated cost $1,500,000.

Ill., Chicago—Holabird & Roche, 104 South Michigan Ave., Archts., will receive bids until July 14 for the construction of a 6 story office and warehouse including steam heating system, 8 elevators, etc. at 23rd and Rockwell Sts. for Illinois Bell Telephone Co., 212 West Washington St.

Ill., Chicago—Koenigsburg & Weisfeld, 105 North Clark St., Archts., are receiving bids for the construction of a 13 story apartment including mechanical refrigeration plant, pumps, etc. for One Thousand Two Hundred Forty Six Boulevard Building Corp. Estimated cost $800,000.

Ill., Chicago—J. A. Roach, 7614 Eastlake Terrace, is having plans prepared for the construction of a 15 story apartment at Sheridan Road and Birchwood Ave. Estimated cost $1,500,000. L. C. Bouchard, 160 North La Salle St., is architect.

Ill., Danville—Danville Building Corp., c/o J. J. Redding & Co., 10 North Clark St., Chicago, Contrs., awarded contract for the construction of a 10 story office, stores and theatre building at North Vermillion and Madison Sts. here. Estimated cost $2,000,000. Three electric elevators, etc. will be installed.

Ind., Anderson—City, C. B. Steele, plans the construction of a new boiler room for water and light plant.

Ind., Angola—County Comrs., F. O. Watkins, Auditor, will receive bids until Aug. 1. for the construction of a power plant and boiler room, etc. Estimated cost $50,000. E. I. Brown, 309 First National Bank Bldg., Ft. Wayne, Inc., is architect.

Ind., Indianapolis—Pennfore Realty Co., 1701 North Illinois St., is having plans prepared for the construction of a 12 story hotel at 14th and Pennsylvania Sts. Estimated cost $800,000. F. B. Hunter, 912 State Life Bldg., is architect.

Ia., Oskaloosa—Des Moines Light Co., 312 Sixth St., Des Moines, will build tower, 30 ft. high, 53 x 69 ft. complete with equipment for electric switch house. Estimated cost $225,000. Private plans. Work will be done by owners' forces under the supervision of E. H. Behrens, Engr. of Construction.

Kan., Hutchinson—United Power & Light Co., will build an electric light plant by day labor. Estimated cost $30,000. Private plans.

Mass., Boston—Hospital Dept., J. P. Manning, Chn., Harrison Ave., will receive bids until July 12 for addition to boiler room and pump house at City Hospital, Albany St. Estimated cost $200,000.

Mass., East Walpole—Birs & Sons Inc., are receiving bids for extensions and improvements to a turbine room. Private plans.

Mass., Waltham (Boston P. O.)—J. P. Morrisey, 19 Massassoit St., plans the construction of a cold storage warehouse. Architect not selected.

Mass., Worcester—Boston & Albany R.R., South Station, Boston, awarded contract for the construction of a boiler house and compressor room here, to J. F. Fitzgerald Construction Co., 38 Chauncy St., Boston.

Mich., Allegan—Superintendents of Poor, A. C. Estabrook, Secy., will receive bids until July 15 for the construction of a power and heating plant, etc.

Mich., Grand Rapids—Syndicate, c/o J. J. Redding & Co., 10 North Clark St., Chicago, Ill., Contrs., awarded contract for the design and construction of a 6 story theatre and apartment building at Lake Drive and Wealthy Sts. here. Estimated cost $1,000,000.

Mo., St. Louis—St. Louis Amusement Co., 706 North Grand Blvd., awarded contract for the construction of a theatre and stores building at Easton and Hamilton Sts. to Boaz-Kiel Construction Co., Ambassador Theatre Bldg. Estimated cost $750,000.

Mo., St. Louis—Syndicate, c/o J. Slupsky, Flora Realty & Investment Co., 5526 Pershing Ave., is having preliminary plans prepared for the construction of a 16 story hotel including steam heating system, etc. at Washington Ave. and Sixth St. Estimated cost $1,500,000.

N. H., Durham—University of New Hampshire, will soon award contract for the construction of a heating plant. Estimated cost $25,000. E. T. Huddleston, is engineer.

N. Y., New York—Owner, c/o Tillion & Tillion, 415 Lexington Ave., Archts., is having plans prepared for the construction of a church and hotel including steam heating and ventilation systems, boilers, pumps, elevators, etc. at 76th St. and Broadway. Estimated cost $2,500,000.

N. Y., Niagara Falls—Certain-teed Products Corp., 100 East 42nd St., New York, awarded contract for the construction of a power plant to Laur & Mack, Buffalo.

Okla., Arnett—City voted $30,000 bonds for the construction of a water and light plant. C. V. Ward, is engineer.

Okla., Ponca City—Bd. of Commissioners, will receive bids until July 14 for the construction of a power plant. Estimated cost $150,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Texas—Comal Power Co., New Braunfels, is having preliminary plans prepared for the construction of a new 60,000 kw. generator unit for plant. Estimated cost $150,000. Private plans.

Tex., Cottage Grove—City, c/o W. G. May, awarded contract for the construction of a sewage pumping station, etc. to V. H. Williford, 1330 Castle St., Houston. Estimated cost $120,000.

Tex., Cuero—City is having plans prepared for waterworks improvements including pumping equipment, mains, etc. Estimated cost $12,000.

Tex., Matagarda—Mayside Beach Development Co., c/o Chamber of Commerce, San Antonio, will soon receive bids for the construction of an 8 story hotel here. Estimated cost $700,000. Private plans.

Tex., Port Lavaca—Bayside Beach Inc., Kirby Bldg., Dallas, will soon receive bids for the construction of a hotel including swimming pool, etc. at Bayside Beach. Estimated cost $700,000. Ferrand & Fitch, 701 Slaughter Bldg., Dallas, are architects.

Tex., Texas City—Texas City Power Co., awarded contract for extensions and improvements to light plant to Service Electric Co. Estimated cost $75,000.

Tex., Waco—Lang & Witchell, 300 American Exchange Bldg., Dallas, Archts., will soon receive bids for the construction of a 14 story hotel here for Hilton Hotel Co., 1933 Main St. Dallas. Estimated cost $700,000.

Utah, Ephraim—City voted $40,000 bonds for the construction of a new hydro-electric plant, 135 to 330 hp. capacity.

Equipment Wanted

Boilers—City, C. B. Steele, Anderson, Ind., plans the installation of boilers in proposed new boiler room for light and water plant.

Engine and Generator—Borough of Pitcairn, Pa., W. M. Hicks, Secy., will receive bids until July 19 for a 300 to 400 hp. Diesel oil engine direct connected to a.c. generator, 3 ph., 60 cycle, 2300 v.

Power Plant Equipment — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of equipment for power plant including hot water storage heater, swichboard, etc. at Naval Hospital.

Power Plant Equipment—El Paso Electric Co., H. C. Webb, El Paso, Tex., plans to purchase and install complete equipment for proposed power plant at Sierra Blanca, Tex. Estimated cost $75,000.

Pumping Equipment—Real Estate Board, T. E. Ackers, et al, Jacksonville, Tex., will receive bids after July 10 for pumping equipment, etc. for proposed waterworks improvements at Midway, Tex. Estimated cost $35,000.

Pumps, Etc.—Lima Lake Drainage Dist., W. J. Smith, Clk., Quincy, Ill., will receive bids until July 8 for three 36 in. centrifugal pumps, etc. for proposed pumping station.

Pumps and Motors—G. C. Mitchell, Clk, Carter, Okla., will receive bids until July 12 for two deep well pumps and motors for proposed new waterworks system. Estimated cost $31,000.

Refrigeration Equipment, Etc.—San Joaquin County, Stockton, Calif., plans the installation of refrigeration equipment, etc. in preventorium at Murphy's, Calvaras county.

Transformer and Switching Equipment—United Electric Light Co., L. J. Scott, Mgr., State St., Springfield, Mass., plans the installation of transformer and switching equipment in plant at West Springfield, Mas Estimated cost $650,000.

Turbine, Boilers, Condensing Equipment, Etc.—Oil Belt Power Co., J. E. Lewis, V. Pres., Eastland, Tex., plans to purchase and install a 15,000 kw. turbine with boilers, condensing equipment, etc., for proposed improvements to power plant. Estimated cost $400,000.